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Microfluidic technologies for the point of care-beyond lateral flow

Leanna M. Levine
Aline Inc., USA

The cost constraints and needs in the point of care market require technology solutions that provide the sophistication for multiple analyte addition, quantitation and multiplexing, while offering a path to low cost high volume manufacture. Roll to roll processes provide low cost of manufacture at high volume and are currently used for glucose sensor manufacture. Yet proof of concept and development work is not suited to roll to roll processing because of tooling and set-up costs. In this paper, we discuss a batch process that provides the on-board microfluidic functions for complex assays, and which has the reliability and manufacturability to meet the need for low cost high volume manufacture.

Biography

Leanna M. Levine received her Ph.D. degree in Biophysical Chemistry from Washington University, St. Louis in 1986. She founded ALine, Inc. in 2003 to address market need for high quality microfluidic prototypes that could be made inexpensively and with rapid turnaround. The business was started in the garage, and was boot strapped through client projects and a small injection of owner capital. The business became cash flow positive in three years, developing capabilities that have a clear focus on the needs of the life science and *in vitro* diagnostic clients who seek to shorten the product development timeline while creating a superior product solution. She conceived and developed ALine's unique and proprietary enabling fabrication platform that permits rapid prototyping and volume manufacture of complex microfluidic and lab on a chip devices. This has significantly lowered the cost of product development and enables the use of complex, higher functionality devices that are robust and disposable. In 2009, ALine was honored as the supplier to the Medical Design Excellence Award winner. ALine was among a selected few finalists for the 2012 Innovation Award sponsored by Patrick Soon Shiong and LA Business Journal. In 2012, ALine achieved ISO 9001:2008 certification and has located to larger facilities.

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In-cell recording and stimulation of neural activity by engulfed microelectrodes

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Currently, neuroscientists study the electrical activity of large populations of neurons using arrays of extracellular microelectrodes (MEAs). Whereas this technology permits high density, simultaneous, long-term recording of extracellular field potentials, it is "blind" to sub threshold synaptic potentials generated by single cells and thus precludes the deciphering of large-scale processes of plasticity, learning and memory. Intracellular recordings of the full electrophysiological spectrum which includes sub threshold synaptic potentials, membrane oscillations and action potentials, are obtained only by the traditional sharp- or patch-microelectrodes and are limited to single cells at a time and for short periods of time.

Here, the development of novel arrays of protruding mushroom-shaped microelectrodes is presented. This neuro-electronic sensor is based on three converging cell biological principles: (1) the activation of endocytotic mechanisms by which the cultured cells are induced to actively engulf the protruding electrodes, (2) the tightening of the cleft between the cell's membrane and the engulfed electrode, generating high seal resistance, and (3) the localization of ionic channels in the plasma membrane that faces the active region of the sensor. This technology merges the advantages of extracellular MEAs and intracellular microelectrodes and enables for the first time long-term, multi-site, parallel in-cell recording of intracellular sub threshold neuronal events. Further development and application of this sensing modality will help steer brain-circuit research toward previously uncharted territories.

Biography

Aviad Hai has completed his Ph.D. from The Hebrew University and is now a postdoctoral fellow at the Massachusetts Institute of Technology. He has won the prestigious Edmond and Lili Safra Brain Center (ELSC) fellowship and the European Molecular Biology Organization (EMBO) fellowship. He is the first author of highly cited papers in the field of biosensors published in top journals such as Nature Methods, Lab-on-Chip and Biosensors & Bioelectronics.

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Electrical percolation based biosensors

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Electrical percolation which is the formation of long-range connectivity in random systems is a new biosensor which enables to measure biological interactions directly and electronically. It is based on biological semiconductor (BSC) which is a multi-layer 3-D carbon nanotube-antibody network, in BSC the passage of current through the conductive network is dependent upon the continuity of the network. Molecular interactions, such as binding of antigens to the antibodies, disrupt the network continuity causing increased resistance of the network. BSC can be fabricated by immobilizing a pre-functionalized single-walled carbon nanotubes (SWNTs)-antibody complex directly on a Poly(methyl methacrylate) (PMMA) surface (also known as plexi-glass or Acrylic). BSC was demonstrated for direct (label-free) electronic measurements of antibody-antigen binding, at slightly above the electrical percolation threshold of the network, binding of a specific antigen dramatically increases the electrical resistance. Using anti-Staphylococcal enterotoxin B (SEB) IgG as a "gate" and SEB as an "actuator", we demonstrated that the BSC was able to detect SEB at concentrations of 1 ng/ml. The new BSCs may permit assembly of multiple sensors on the same chip to create "Biological Central Processing Units (CPUs)" with multiple biological elements, capable of processing and sorting out information on multiple analytes simultaneously.

Biography

Avraham Rasooly, Ph.D. is serving as Special Assistant for Cancer Technologies and Translational Research at the Division of Cancer Biology, National Cancer Institute. Dr. Rasooly laboratory at the Division of Biological Science at the FDA's Center for Devices and Radiological Health (CDRH) is studying biosensor technologies for rapid biodetection and diagnostics. Dr. Rasooly has published over 90 scientific publications and he edited five volume books on biodetection technologies the most recent one is on biosensors for cancer detection and diagnosis.

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Microcantilever tools in biosensing: A brief survey

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Biosensors based on microcantilevers have become a promising tool for directly detecting biomolecular interactions with great accuracy. Changes in microcantilevers resonant frequency or their bending can be monitored by optical (Bragg fiber interferometry or laser beam deflection in Atomic Force Microscopy) and electrical techniques: piezoresistive, capacitive, magnetic (magneto-resistive, strictive or motive), electron tunneling current. Piezoresistive microcantilevers are widely spread in cell mechanobiology, ranging from tissue level to individual proteins and DNA. They are made of various materials (ultrathin steel foils, gold probes, glass, soft polymers, hard silicon-based devices or carbon nanotubes), using different fabrication processes: integrated circuitry, soft lithography or focused ion beam etching. Piezoresistive microcantilevers cover a lot of shapes (I, A, V, U, "hook", "putter"), sometimes optimized by finite element analysis. They exhibit high or low aspect ratios (length vs. width) depending on the type of biological application. For improving the measurement sensitivity, apart from the mechanical "shaping", several electronic methods of gain augmenting are used, e.g. the piezoresistive effect in silicon resulting in a resistance change with applied stress, as a function of crystal orientation, dopant type and doping concentration. A smart electromechanical "combination" consists in a field effect transistor located under a vibrating microcantilever, where pre-bending significantly increases the sensitivity (US Patent 2012). Also, multiple microcantilever arrays have been introduced for highly sensitive detection of biomolecules in disease diagnostics, genomics research and other applications in biosensing.

Biography

Dan Mihai Ştefănescu received his B.S. degree in Applied Electronics (1969), M.S. in Experimental Stress Analysis (1983) and Ph.D. cum laude in Electrical Engineering from the "Politehnica" University of Bucharest, Romania (1999). He was the Head of Metrology and Instrumentation with the National Institute for Aerospace Research, Bucharest. He completed a Post-Doctoral Fellowship (NATO grant) on Knowledge-based Intelligent Systems for Selecting Industrial Sensors, with the Twente University of Enschede, The Netherlands. He was Visiting Scientist with the Korean Research Institute of Standards and Science and with the Center for Measurement Standards, Hsinchu, Taiwan. He is currently Senior Consultant with the Romanian Measurement Society and the Romanian representative for IMEKO (International Measurement Confederation). His current research interests include electrical measurement of mechanical quantities, material testing installations and metrological procedures for multicomponent transducers.

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Image guided treatment planning system for percutaneous radio frequency ablation

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Compared with surgical resection of tumors, percutaneous radiofrequency ablation (RFA) has emerged as a viable minimally invasive technique for the treatment of cancers in organs, such as bone, lung or liver. The tumor ablation procedure employs needle-like probes which can be inserted percutaneously to the target tumor and deliver 'burning heat' to kill the cancerous tissue. The current practice of ablation planning is highly dependent on the operator's experience from looking at the preoperative or intra-operative images. Its success rate is greatly influenced by the biological conditions (critical surrounding organs, tumor size), thus the need for computer-assisted interventions to provide a more comprehensive description of the surgery. For large tumors that cannot be completely killed by one ablation even with large electrodes, multiple ablations are needed to cover the whole tumor and a safety margin. To address these challenges, we present a computer-assisted imaged-guided planning system incorporating mathematical optimization and augmented reality. Sphere covering optimized by genetic algorithm are used for complete tumor coverage planning; voxels and optimization equations are employed to calculate optimized needle trajectories. The patient specific model are derived from the dignostic CT images with the safety margin, then the treatment optimization module derives optimal probe insertion trajectories as well as optimal placement locations of ablation electrode. The optimization formulation is structured to satisfy the constraints of complete tumor coverage using multiple overlapping ablations, starting from specified entry points, avoiding critical no-fly zone, while minimizing the number of ablations and skin punctures. The proposed multiple-objective optimization for probe insertions incorporates both clinical and technical constraints and has been validated in the experiments.

Biography

Hongliang Ren is currently an Assistant Professor and a PI of medical mechatronics in National University of Singapore (NUS). He received his Ph.D. in Electronic Engineering from The Chinese University of Hong Kong (CUHK), and conducted postdoctoral research in the The Johns Hopkins University, Surgical Innovation Institute of Children's National Medical Center, and the Pediatric Cardiac Bioengineering Lab of Children's Hospital Boston & Harvard Medical School. His research interests are in Computer-Integrated Surgical (CIS) systems, biomedical mechatronics, medical robotics and sensing technologies.

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New trends in nanomaterials based electrochemical biosensor towards health care

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The use of nanomaterials in the development of electrochemical biosensors are gaining importance due to their ability to generate new signal transducers for enhancing the sensitivity and performance of a biosensor. Because of their nanoscale dimensions, systems based on nanomaterials allow simple and rapid chemical and biological analyses of multiple substances *in-vitro* as well as *in vivo*. Here we report some of our major achievements related to the developments of electrochemical biosensors for health care.

A reduced graphite oxide/Bismuth (RGO/Bi) nanocomposites has been used as electrode material for electrochemical detection of heavy metal ions. Trace analysis of Cd^{+2}, Pb^{+2}, Cu^{+2} and Zn^{+2} in water was carried out by stripping voltammetric analysis, and the sensitivity and detection limit of the electrode were quantitatively estimated. The three sigma detection limits at different deposition potential for Cd^{+2}, Pb^{+2}, Zn^{+2} and Cu^{+2} were obtained as 2.8, 0.55, 17 and 26 mg L^{-1}, respectively. Copper detection using Bi-film electrode was a major challenge, which has been resolved using the RGO/Bi nanocomposite electrode. Yet in another approach, iron oxide nanoparticles were anchored on reduced graphene oxide (RGO) nanosheets and their electrochemical behavior towards chromium ion was assessed using cyclic voltammetry. Expanding the horizons of these electrochemical sensors, iron oxide was successfully evaluated for the detection of cervical cancer cells and was established as an impedimetric biosensor with very low detection limits. PEGylated arginine was the functionalization entity of iron oxide anchoring the immunoglobulin-G which served as recognition site for the surface receptors of HeLa cells.

Biography

Dhirendra Bahadur is presently an institute chair professor at Department of Metallurgical Engineering and Materials Science, IIT Bombay, India. His research interests include nanostructured oxide materials, their hybrids, graphene and its composites, magnetic materials at nanoscale and biomedical applications. He is presently in the editorial board of Chinese Journals of Clinicians and Journal of Magnetism and Magnetic Materials. He is coauthor/author of more than 260 publications in international journals, book chapters, four books and seven patents. He has several awards and honors to his credit including the national research award of the Govt. of India which he received this year.

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Development of intracorporeal surgical tracking device with tightly coupled sensor fusion approach

Hongliang Ren, Wei Liu and Shuang Song
National University of Singapore, Singapore

Surgical navigation systems enable surgeons to carry out surgical interventions more accurately and less invasively, by tracking the surgical instruments inside human body with respect to the target anatomy. In order to get the real-time position and orientation measurements of surgical instruments in the surgical field, we developed a new miniature tracking device, which is aiming to overcome the constraints of line-of-sight and interference in surgical environment. Currently, optical tracking (OPT) is the gold standard in surgical navigation systems because of its accuracy but is constrained by direct line of sight (LOS) between camera sensors and markers. Electromagnetic tracking (EMT) technology is an alternative without the requirement of LOS, whereas EMT is prone to measurement errors caused by environmental ferromagnetic distortion. An idea for solving these dilemmas is to integrate respective strengths to overcome the corresponding weaknesses. Instead of conventional post-acquisition loosely coupled fusion of sensor measurements, we built a real-time hybrid tracking system as illustrated in the below figure and developed a "pre-data fusion" method, which emphasizes the interactive and tightly coupled fusion of EMT and OPT sensor data for pose estimation. The primary contribution of this study is that LOS problem and point correspondence problem can be mitigated using the initial measurements of EMT, and in turn the OPT result can be the initial value for non-linear iterative solver of EMT sensing module, in order to increase the tracking accuracy of EMT. The experiments show that the mean position estimation error is 0.87 mm.

Biography

Hongliang Ren is currently an assistant professor and a PI of medical mechatronics in National University of Singapore (NUS). He received his Ph.D. in Electronic Engineering from The Chinese University of Hong Kong (CUHK), and conducted postdoctoral research in the Johns Hopkins University, Surgical Innovation Institute of Children's National Medical Center, and the Pediatric Cardiac Bioengineering Lab of Children's Hospital Boston & Harvard Medical School. His research interests are in Computer-Integrated Surgical (CIS) systems, biomedical mechatronics, medical robotics and sensing technologies.

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Quartz crystal microbalance (QCM) based nanobiosensors: An effective tool for pathogen detection

Prashant Singh
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Pathogen detection and its analysis are critical for medicine, food safety, agriculture, public health and biosecurity. Many current microbial detection approaches are based on century-old culturing methods, which are reliable but slow and provide relatively little information about the pathogens and also are not adaptable to high throughput operations. The availability of many instruments, procedures and techniques like spectrophotometer, calorimeter, flow cytometer, polymerase chain reaction, spectroscopy etc. need costly equipments and highly skilled personnel to limit their practical use, which creates a demand for development of a low cost diagnostic tool with very high sensitivity and specificity; and quartz crystal microbalance (QCM) based nanobiosensors best meet this requirement.

QCM based nanobiosensors could be a thrilling alternative to the traditional methods for the detection of pathogens by enhancing its efficacy and efficiency by suitable nanomaterials. In the recent years, many workers have started employing nanomaterials in QCM to develop the nano-biosensors. This strategy could be seen as a key to yielding devices and demonstrates rapid responses combined with high sensitivities. Indeed, these traits have nearly become standard attributes of this technological combination and arise from the extremely high surface and small size nanostructure areas as nanotubes, nanopores, nanowires and nanoparticles. In view of above, it is acceptable to state that QCM based nanobiosensor has the potential to increase sensitivity and specificity, speed up the detection and enable high-throughput analysis. In the present study, the employment of nanomaterials in QCM have been critically reviewed and categorically analysed on the performance basis.

Biography

Prashant Singh is presently working as Associate Professor at Department of Chemistry, DAV (PG) College Dehradun, Uttarakhand, India since 2000. He obtained his Ph.D. degree in Chemistry from University of Roorkee, Roorkee (Presently Indian Institute of Technology, Roorkee), India in 1996. Dr. Singh has published over 60 research papers in national and international journals. His research interests are water chemistry, environmental sciences and nano-biosensors for water characteristics. He is engaged in promoting and popularizing Science and Technology in the state. He is presently the Chief Editor of a reputed journal 'Analytical Chemistry Letters' published by Taylor and Francis.

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FET based sensor indentifying and quantifying cellular communication through specialized structure at interfacial cell wall for graft success in plants

Rajiv Dutta
Graphic Era University, India

Electrical resistances of auto grafts and hetero graft of various plants like *Lycopersicon esculentum* and *Amaranthus tricolor* have been measured and found to be a significant means for measure of graft union. The present study deals with the measurement of electrical resistance in some other plants like rose, tea and tissue cultures grown cashew and its pattern of variation at different days after grafting. The present study also examines the existence of inter cellular communication via plasmodesmata appeared at the graft interface when drop of electrical resistance occurs in graft union. The appearance of plasmodesmata at contact surface of the scion and root stock at different time interval of the graft has been confirmed by light and electron microscopy. This study enumerate that this phenomenon is a universal indicator for graft union in plants. A FET and MOSFET based sensor was designed for the measurement of electrical resistance at interfacial graft surface.

In addition to this, weak electric current at the order of milli-amperes were passed through the interfacial graft surface and astonishing results were seen at the graft interface and were also authenticated by the microscopic observations.

Biography

Rajiv Dutta earned his M.Tech. (IIT-Kharagpur), Ph.D. (BITS-Pilani) and D.Sc. (IUCM-Colombo, Sri Lanka). Presently, he is the Dean, Faculty of Biological Engineering, Graphic Era University, Dehradun. He has wide research and academic experience in Universities/Institute in India and abroad. He published several research papers in high impact journals which were highly cited and served as Editorial Board Member for journals of international repute. He has received several awards including ISCA Young Scientist Lecture Award, World Congress of Natural Medicine Young Scientist Gold Medal, JCI Outstanding Young Person of India, Erwin Neher Diamond Jubilee Oration, and Dr. Ramesh Gulrajani Memorial Award for his outstanding contribution.

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Molecular sensing based on optical whispering-gallery mode microsensors

Zhixiong Guo
Rutgers University, USA

In this plenary talk, we will discuss optical whispering-gallery modes (WGM) resonance and its applications in nanoscale detection and molecular level sensing. The sensing principle is either an evanescent electromagnetic field interacts with target biomolecules adsorbed or covalently attached to the microsensor surface or a resonant field interacts with target molecules trapped inside a resonator, and consequently induces changes in the optical resonance spectrum. For example, a porous ring microresonator integrated in a micro electrofluidic system can function as both a filter and an optical WGM sensor. The microelectrofluidic forces augment substantially the filtration capability of the system, which separates the target molecules from solution and enriches the analyte deposition inside the porous resonator. This alters the optical properties of the resonator and shifts the optical WGM resonance frequency, leading to potential label-free ultrasensitive detection of small molecules at picomolar concentration levels and below.

Biography

Zhixiong Guo is a Professor at Rutgers, The State University of New Jersey, and a Fellow of American Society of Mechanical Engineers. He holds a doctorate in both Engineering Physics and Mechanical Engineering. His specialty lies in the modeling and experimental analysis of radiation-matter interactions and applications in nanoscale optical sensing, lasers in biomedicine, and thermal management. He proposed detection of single bio/chemical molecules using optical whispering-gallery modes. He has published more than 70 papers in reputed journals and serving as an associated editor and editorial board member of repute.

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Ultrasensitive detection of cancer cells based on anticancer-drug membrane interaction and selective silver deposition

Pranjal Chandra
Amity University, India

Simple, sensitive, and general cancer detection methods are required in the point-of-care diagnostics. Conventional clinical approaches to detect cancers are based on biopsy followed by histopathology, biomarkers detection through genomics and proteomics tools based on the protein or nucleic acid contents. In this presentation I will discuss two novel methods of cancer detection based on the selective signal amplification through silver ions deposition and the interaction between anticancer drug and the cell membrane component. These detection strategies are based on the development of biosensor where an antibody and/or aptamer was attached on nanoconducting material. In first section, the human epidermal growth factor receptor 2 (HER2) and HER2-overexpressing breast cancer cells were detected using an immunosensor combined with hydrazine and aptamer conjugated-gold nanoparticles (AuNPs). The hydrazine-AuNP-aptamer conjugate, where the hydrazine reductant was directly attached onto AuNPs to avoid the nonspecific deposition of silver on the sensor surface was designed and used to reduce silver ion for signal amplification, selectively. The fabricated biosensor was capable of differentiating between HER2-positive breast cancer cells and HER2-negative cells. This method exhibited an excellent diagnosis method for the ultrasensitive detection of SK-BR-3 breast cancer cells in serum samples with a detection limit of 26 cells/mL. In second part, the interaction between an anticancer drug, daunomycin (DAN) and cancer cell membrane components has been studied using an aptamer probe immobilized on a nanoconducting film through electrochemical and fluorescence method and applied for the quantitative detection of cancer cells. The developed method differentiates between cancerous and noncancerous cells effectively.

Biography

Pranjal Chandra is M.S. in Microbiology, M.Tech. in Biotechnology, and earned his Ph.D. degree from the Institute of Bio-Physio Sensors Technology, Department of Chemistry, Pusan National University, Busan, South Korea on "Development of Electrochemical Biosensors for Cancer Diagnosis Based on Conducting Polymers and Nanomaterials". Currently he is Assistant Professor at Amity Institute of Biotechnology, Amity University, India. He has published more than 25 papers, book chapters, and is the editor and reviewer of various reputed journals. He is interested to combine microbiology, biotechnology, nanotechnology, electroanalytical chemistry, and molecular biology approaches to address the problems of biomedical significance and diagnostics.

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DNA aptamers combined with biosensors for biomarker measurement in human serum

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Vista Therapeutics, Inc. and Base Pair Biotechnologies, Inc. are collaborating to create a powerful collection of Nanowire-Aptamer probes whose sensitivity and ease of use is currently unmatched. Using Vista's proprietary 'Universal Linker' system, aptamers can be readily attached to Vista's nanowires without modification. Vista has demonstrated that Base Pair's aptamers can be used quite successfully with nanowires as probes for protein analyte seven in human blood serum. Because aptamers are small, have a single attachment site, and because they are linearized prior to covalently attaching them, they coat the nanowire surface much more thoroughly than antibodies. This increases signal strength and greatly improves the signal: noise ratio. In addition, aptamer-coated nanowires can be dried and rehydrated many times without loss of signal. And since aptamers are simply DNA strands, Vista and Base Pair can easily create Nanowire-Aptamer probes to DNA, mRNA, microRNA. Using Nanowire-Aptamer probes, the end user can measure combinations of transcripts, proteins, microRNA's and DNA sequences in the same reaction. We present specific detection of Heat Shock Protein 27 (HSP27) and fibronectinin PBS and blood serum by aptamers selected by Base Pair and immobilized on Vista nanowires.

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Electrochemical and biomagnetic catechol sensor based on polyaniline-iron oxide magnetic nanohybrid

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[2]Lehrstuhl für Anorganische Chemie, Deutschland

Polyaniline–iron oxide magnetic nanohybrid was synthesized and characterized with spectroscopic, microstructural and electrochemical techniques. The smart integration of Fe_3O_4 nanoparticles with polyaniline (PANI) yielded a mesoporous nanohybrid (Fe_3O_4@PANI) with high surface area (94 m^2/g) with average pore width of 12.8 nm. Transmission electron microscopy (TEM) revealed granular Fe_3O_4@PANI nanohybrid containing several monodispersed Fe_3O_4 nanoparticles interlaced within the PANI matrix. K-edges of C, N and O of PANI and Fe L2 and L3 edges of Fe3O4 were identified by electron energy loss spectroscopy (EELS). Cyclic voltammetry indicated that catechol is quasi-reversibly oxidized to o-quinone and reduced at the Fe_3O_4@PANI modified electrodes. The amperometric current response towards catechol was observed with sensitivity and detection limit of 312 μA/μL and 0.2 nM, respectively. Electrochemical impedance spectroscopy (EIS) indicated that catechol tends to adsorb faster on the modified electrodes giving rise to increased solution resistance (R_s). Photoluminescence spectra showed ligand-to-metal charge transfer (LMCT) between pπ orbitals of phenolate cathecolate oxygen and dσ* metal orbital of Fe_3O_4@PANI composite. Potential dependent spectroelectrochemical response of Fe_3O_4@PANI towards catechol was studied using UV/Vis/NIR spectroscopy. AC susceptibility measurements support the binding activity of biomagnetic particles with catechol through Brownian relaxation. The peak frequency of the AC susceptibility is inversely proportional to the particle volume, and can be used to monitor the change in the particle volume upon binding of catechol to Fe_3O_4@PANI. The use of Brownian relaxation time in frequency domain provides a platform for developing a biomagnetic sensor.

Biography

Sudeshna Chandra has completed her Ph.D. at the age of 28 years from University of Roorkee and was a Humboldt Fellow at Technische Universität Chemnitz, Germany. Currently, she is a woman scientist in Department of Metallurgical Engineering and Materials Science, Indian Institute of Technology Bombay, India. She has published more than 40 papers in reputed journals and has attended many national and international conferences.

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A novel lab-on-cartridge device for the measurement of HbA1C

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Piramal Enterprises Limited, India

Piramal intends to leverage its expertise in biosensors/immunosensors and microfluidics to design and develop the world's first QDx A1C, a paradigm shift, point-of-care, self-calibrating (using on-board reagents and micro pumps in a micro fluidic cartridge format) high performance (sensitivity ng/mL, & specificity as per antibodies), inexpensive (<$1.00) cartridge for rapid (in minutes) quantitative measurement of low concentration disease markers in whole blood/serum samples which, will result in a point-of-care, and- held device for rapid screening and diagnosis of diabetic disease markers. Our proposed method utilizes a novel; inexpensive microfluidic cartridge based electrochemical immunosensor. The electrochemical immunosensor utilizes Enzyme Immunoassay in microliter of blood sample using Chronoamperometry technique and the Highly Reliable Methodology of On-Board Reagent Washing. We have demonstrated the Proof-of-Concept of QDx A1C using HbA1C as our target marker in patient whole blood samples with a detection range of 5% to 15% HbA1C. The developed technology platform can now be easily adapted for low cost, sensitive and rapid measurement of cardiac/thyroid markers and infectious diseases in low resource settings such as in semi-urban and rural areas in the developing countries.

Biography

Vijaywanth Mathur is the Vice President of Diagnostics R&D at Piramal Enterprises in Mumbai, India. He has 18+ years of Research & Development experience and 12 patents in the field of electrochemical biosensors/immunosensors and medical diagnostic instrumentation. He has worked in major US based diagnostic companies and startup companies where he has released six different families of medical diagnostic instruments from concept to production. He did his M.S. from Case Western Reserve University, Cleveland, Ohio and his career interests include lab-on-chip, microfludics, Bio MEMS and electrochemical DNA/aptamer biosensors.

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Chemiluminescence immuno-detector based on single planar transparent digital microfluidic device

Jia Zhou, Xiangyu Zeng, Kaidi Zhang and Jian Pan
Fudan University, China

We reported a compact and portable prototype of chemiluminescence immuno-detector based on a single planar transparent electro wetting-on-dielectrics (EWOD) device. The single planar transparent EWOD device was realized by a coupling ground electrode which could be driven under a single polar voltage. Such design not only simplified the chip construction and control circuitry, but also made the ball-like droplet itself focus the florescence and thus enhance the detection sensitivity. The sensitivity of the prototype detector was 5.45 mV/mmol/L and the detection limit was 0.01 mmol/L when the contact angle of the EWOD surface was 120°. Further increase of the sensitivity and decrease of the detection limit could be achieved by increasing the contact angle of the EWOD device and decreasing the dark current of the photomultiplier. Such detector shows promises for cost effective and portable diagnoses of blood glucose.

Biography

Jia Zhou received her Ph.D. degree from Fudan University in 2004. Her research interests focus on chemical and biological sensors and their applications. She has published over 90 papers.

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Biosensor platforms with nanomaterials for diagnostics applications

Ibtisam E Tothill
Cranfield University, UK

Since the advent of the biosensor for glucose monitoring around the mid-eighties, there has been a phenomenal growth in the field of biosensor development with emerging applications in a wide range of disciplines, including medical, food and environmental diagnostics. This has been as a result of the increase in demand to develop rapid diagnostic for point- of- care testing and also to comply with legislations and food safety and quality standards.

With the emerging field of nanotechnology, new nanomaterials and micro/nano transducer devices have been introduced to the biosensor arena and applied to develop advanced and highly sensitive sensor devices. Their application in sensor development has been due to the excellent advantages offered by these materials in miniaturisation of the devices, signal enhancements and amplification of signal by the use for example nanoparticles as labels. The use of nanomaterials can increase sensitivity of the final devices and also allow the fabrication of multiplex sensor systems for several analytes analysis to be taken place at the same time. At Cranfield we are applying nanomaterials in the development of assays and sensors for a range of analytes detection. This is in order to achieve higher sensitivity when using electrochemical transducer and also optical (SPR) and quartz crystal microbalance sensors (QCM) sensor systems. This presentation will cover the recent developments and advances in biosensor fabrication and the emerging synthetic receptors and nanomaterials used for their developments giving examples of recent work conducted by the group.

Biography

Ibtisam E Tothill is a Reader in Analytical Biochemistry and leads the Analytical Biochemistry Research activity within Cranfield Health. She is also the Head of the Advanced Diagnostics and Sensors Group at Cranfield University, UK since 2004 and holds many Visiting Professor Positions in Europe and China. She has served as Programme Director, Deputy Education Director, Associate Dean for the Faculty of Medicine and Biosciences and a Director for the Sensors for Water Interest Group (SWIG).

Her research activity is focussed on the sensors and diagnostics arena covering the medical, foods and environmental sectors. Her current work covers analysis of microbial contaminants and pathogens and their toxins such as mycotoxins, cyanobacterial toxins and endotoxins, metals, and drugs in food, the environment and biological fluids and the detection of disease biomarkers for point-of-care testing with over 100 publications and book chapters covering this arena. She is also involved in several projects where micro/nanosensor arrays and nanomaterials are being developed for rapid analysis applications. Dr. Tothill sits on several Editorial Boards for international scientific journals and scientific committees.

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Bio-impedance tomography

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Bio-impedance tomography is an area of bioengineering with rapid progress in past few years. Electrical and electromagnetic imaging techniques are new and emerging imaging tools with wide range of applications. There is great potential in biomedical applications of electrical and electromagnetic imaging. They provide fast, safe, low cost, non-invasive solution to monitor internal structures and processes where a contrast in passive electromagnetic properties exists and can be measured. In this talk we will present mathematical formulation, computational and experimental challenges for 3D imaging in this area. In particular, nonlinear image and shape reconstruction for 3D imaging will be discussed. The experimental realisation of the volumetric electrical and electromagnetic tomography will be covered. The results will be shown for volumetric imaging for electrical impedance tomography (EIT), electrical capacitance tomography (ECT) and magnetic induction tomography (MIT). Dynamical and 4D image reconstruction methods will be presented. The future directions and challenges in volumetric imaging will be discussed. Further extension includes (but not limited to) multiple-frequency imaging, limited angle imaging, real time imaging, absolute value imaging, and multimodality imaging.

Biography

Manuchehr Soleimani is a lecturer in electronic and electrical engineering from University of Bath, UK. He established the Engineering Tomography Laboratory (ETL) in 2011. Dr. Soleimani has published over 180 academic papers including 75 peer-reviewed papers in international journals and 4 patents following his Ph.D. in 2005. He has edited 4 special issues; including a recent issue of Phil. Trans. of the Roy. Soc. A in "New and emerging tomographic imaging". He is a member of the editorial board of a number of international journals including the International Journal of Tomography & Statistics and Biomedical Engineering Online. He is on the organising committee for several key international conferences and chaired the 12th International Conference in Medical EIT in 2011.

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The use of bioelectrochemical system to detect the pathogenic organisms: Electrochemical activity of *Streptomyces*

Rabeay Y. A. Hassan, Hassan N. A. Hassan, Mohamed Abelaziz and Elmorsy khaled
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Microbial infectious diseases remain a serious public health problem due to the fast-spreading of microbial pathogens, and biological contaminants, in the environment. Since the detection of pathogenic bacteria is necessary to the prevention and identification of health problems, the sensitive detection assays are urgently needed. However, reliable, sensitive, quantitative, and rapid assays for pathogenic microorganisms are not yet readily accessible. Thus, based on the electrochemical communication between the viable cells of pathogens, *Streptomyces* as a target organism, and the nano-electrode a new microbial sensor has been designed for the desirable objective. From the electrochemical and biochemical investigations, the MWCNT-Paste electrode (40% w/w) was used for studying the electrochemical behaviors of *Streptomyces*. As a result, the cyclic voltammogram of viable *Streptomyces* cells exhibited an efficient oxidation current. The oxidation peak height was found to be proportional to the viable cell numbers which enable the electrochemical monitoring of the growth rate at low cells numbers.

Understanding the mechanism of the extra-cellular electron-transfer is essential for the design and optimization of the proposed assay, therefore, a mechanistic study has been carried out. At the end, the electron transport chain of *Streptomyces* showed a great impact on the generated electrical current.

In conclusion, the proposed microbial sensor could be used as a platform for the effective environmental protection and quality control monitoring of the microbial pathogens in medical and environmental samples.

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Application of biosensor in evaluation of food quality

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In recent years as consumer demand traceability and legislation and accountability in the food chain distribution has increased, the need for rapid and verifiable methods of food quality assurance has grown rapidly. Conventional analysis methods for non-biological contaminants include high pressure liquid chromatography (HPLC), liquid chromatography (LC) and gas chromatography (GC) in combination with different detection techniques and enzyme linked immune sorbent assays (ELISA). Because of their sophisticated instrumentation they cannot be applied on in-line monitoring and involves complex, laborious sample pre-treatment technique. Nowadays, sensing technologies for food analysis including optical, chromatographic, calorimetric, etc. are employed. Although biosensors are not commonly used for food microbial analysis, they have great potential for the detection of microbial pathogens and their toxins in food. They enable fast or real-time detection, portability, and multipathogen detection for both field and laboratory analysis. Biosensors have several potential advantages over other methods of analysis, including sensitivity in the range of ng/mL for microbial toxins and <100 cfu/mL for bacteria. Fast or real-time detection can provide almost immediate interactive information about the sample tested, enabling users to take corrective measures before consumption or further contamination can occur. Miniaturization of biosensors enables biosensor integration into various food production equipment and machinery. Potential uses of biosensors for food microbiology include online process microbial monitoring to provide real-time information in food production. Biosensors can also be integrated into Hazard Analysis and Critical Control Point programs, enabling critical microbial analysis of the entire food manufacturing process.

Biography

Santosh Chopde has completed M.Tech. (Dairy Engineering) from NDRI, Karnal (India) and he is presently working as an Assistant Professor at College of Dairy Technology, Udgir.

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Association of a Love wave sensor to thin film molecularly imprinted polymers for nucleotides nanoparticles detection

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The overall objective of this work is to develop and to validate a quantitative, noninvasive diagnosis tool to monitor the efficiency of colorectal cancer chemotherapy. Our methodology takes advantage from the high sensitivity of acoustic biosensor combined with high selectivity and robustness of thin film Molecularly Imprinted Polymers (MIPs) to detect tumor markers (nucleosides nanoparticles). The first step consists in developing a process for thin film MIP coating based on commercial nucleotides Adenosine Mono Phosphate (AMP), to verify the compatibility of the MIP film with acoustic propagation and the sensor sensitivity for the rebinding of AMP.

We chose a MIP surface imprinting strategy, where the polymer film thickness was adjusted in order to establish the optimal film thickness value to meet the sensor insertion losses requirements. Scanning Electron Microscopy (SEM) images reveals the film surface morphology and the pores sizes (500nm to 1 μm). The sensor response was recorded in terms of frequency shift and insertion losses using a network analyzer. The MIP based sensor showed a frequency shift estimated to 6875 Hz for 25ppm AMP concentration. The MIP layer associated to our sensor offers a good stability compared to natural recognition, knowing that sensitivity can be further improved by optimizing the MIP layer. Simplicity of the obtained sensor makes it an attractive candidate as a nucleoside detector for colorectal cancer diagnosis. We work currently on the integration of a new MIP coating based on nucleosides instead of nucleotides. We also envisage associating a microfluidic system for real time detection.

Biography

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Ultra-rapid prostate specific antigen biosensing using magnetic mediation

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Prostate specific antigen cancer (PSA) is a 34 KDa serine protease secreted by the epithelial cells of the prostate gland to liquefy the semen. A higher level of PSA (more than 4 ng/ml) might be a strong indication of prostate cancer. Therefore, we try in this work to construct a washeless and ultra-rapid method for PSA biosensing useful for sensitive and very cheap medical analysis. The technique is based on the modification of a bare gold surface with a self-assembled monolayer of PSA substrate previously labeled with magnetic nano-carriers. The functionalized strip area dipped onto 1 ng/ml PSA containing sample undergoes visible structural changes within 5 min due to the peptide cleavage and the attraction of the released magnetic beads onto the external magnet. With increased PSA concentrations, we can easily observe a further degradation of the magnetic-organic film. Whereas, no significant bare areas appear from the modified strip using a similar construct of non specific peptide and a concentration up to100 ng/ml of the enzyme. Those results suggest the specificity and the rapidity of our detection mechanism which can be implemented into more advanced physical transducers to develop a cost-effective lab-on-a-chip device for diagnostic usage.

Biography

Chiheb Esseghaier got Engineer degree in Industrial Biology from Institut National des Sciences Appliquées et de Technologie (INSAT), Tunis in 2007. After that, he continued his master studies at the same institute in Industrial Biotechnology field and he got the MSc degree in 2008. Then, he moved to Sherbrooke University to work on research project on SPR biosensor and gallium arsenide semi-conductor bio-functionalization. In November 2010, he joined BBBL lab in Institut National de la Recherche Scientifique (INRS) to start Ph.D. program in developing optical and electrochemical biosensors. Chiheb has published several papers in very reputed journals and participated in couple of famous worldwide conferences.

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Dissolvable sucrose barriers as tools for automated fluid control in paper diagnostics

Tinny Liang, Elain Fu and Barry Lutz
University of Washington, USA

The current standard for diagnosis of infectious disease at the point of care (POC), lateral flow tests (LFTs), lack the ability to carry out multi-step processes inherent in gold-standard laboratory-based assays. One solution is to enable automated multi-step processing in paper-based devices using tools to control fluid transport. To this end, we have developed dissolvable sucrose barriers to create fluidic delays within our paper networks and automate sequential delivery of multiple reagents. We demonstrate their ability to produce well-defined fluidic delays from minutes to nearly an hour. Further, we present a paper-based device that can carry out an automated multi-step amplified immunoassay using the dissolvable sucrose barriers.

The assay consists of four steps: (1) delivery of sample premixed with antibody-conjugated gold nanoparticles, (2) delivery of a rinse, (3) delivery of a gold enhancement reagent for signal amplification, and (4) a final rinse. The paper-based device retains the ease of use of conventional lateral flow tests; the user simply adds reagents to the source pads and then folds the card to initiate the assay.

Biography

Tinny Liang is a senior majoring in Bioengineering at the University of Washington. She has spent the last three years working on paper-based diagnostics for low-resource settings in the lab of Professors Elain Fu, Barry Lutz, and Paul Yager. She is a co-author on several publications in this field. She plans to first pursue a Masters in Bioengineering at the University of Washington and then attend medical school.

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Critical stages of a biosensor development from sensor chip fabrication to surface chemistry and assay development

Yildiz Uludag
The Scientific and Technological Research Council of Turkey, Turkey

Once viewed solely as a tool to analyse biomolecular interactions, biosensors are gaining widespread interest for diagnostics, environmental and quality assurance in agriculture/food industries. Biosensors consist of three fundamental components, a receptor, a transducer and an analyzer. While a label is needed for some of the transducers to detect a biological activity between a receptor and its analyte, label-free technologies such as surface plasmon resonance and piezoelectric sensors do not. Advanced micro fabrication techniques have facilitated integration of microfluidics with sensing functionalities on the same chip making system automation more convenient. Biosensor devices relying on lab-on-a-chip technologies and nanotechnology has attracted much of attention in recent years for life sciences research and diagnostics. However, compared with the numerous publications and patents available, the commercialization of biosensor technology has significantly lagged behind the research output. This presentation reviews the reasons behind the slow commercialisation of biosensors with an insight to the critical stages of a biosensor development from the sensor chip fabrication to surface chemistry applications and nanotechnology applications in sensing with case studies for DNA, cancer biomarker and pathogen detection assays.

Biography

Yildiz Uludag has degree in chemical engineering (BSc; METU, Turkey), biotechnology (Ph.D.; Cranfield University, UK) and more than 10 years of professional experience in the area of biosensors. Dr. Uludag worked at two University of Cambridge spin-off companies (Affinity Sensors and Akubio Ltd.) at different positions. Currently she holds a senior researcher position at UEKAE-TUBITAK. Not only did she use different commercial biosensor instruments (optical, piezoelectric and electrochemical) but was also involved in the development of new biosensor devices and sensor chips from prototype to commercial products, and some of the products she developed, or was involved in its production are in the market.

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Investigation of characteristics of urea and butyrylcholine chloride biosensors based on ion-selective field-effect transistors modified by the incorporation of heat-treated zeolite beta crystals

Esin Soy
Middle East Technical University, Turkey

Urea and butyrylcholine chloride (BuChCl) biosensors were prepared by adsorption of urease and butyrylcholinesterase (BuChE) on heat-treated zeolite Beta crystals, which were incorporated into membranes deposited on ion-selective field-effect transistor (ISFET) surfaces. The responses, stabilities, and use for inhibition analysis of these biosensors were investigated. Different heat treatment procedures changed the amount of Brønsted acid sites without affecting the size, morphology, overall Si/Al ratio, external specific surface area, and the amount of terminal silanol groups in zeolite crystals. Upon zeolite incorporation the enzymatic responses of biosensors towards urea and BuChCl increased up to ~ 2 and ~ 5 times, respectively; and correlated with the amount of Brønsted acid sites. All biosensors demonstrated high signal reproducibility and stability for both urease and BuChE. The inhibition characteristics of urease and BuChE were also related to the Brønsted acidity. The pore volume and pore size increases measured for the heat-treated samples are very unlikely causes for the improvements observed in biosensors' performance, because urease and BuChE are approximately one order of magnitude larger than the resulting zeolite Beta pores. Overall, these results suggest that the zeolites incorporated into the biologically active membrane with enhanced Brønsted acidity can improve the performance of ISFET-based biosensors.

Biography

Esin Soy has completed her M.Sc. degree at the age of 25 years from Middle East Technical University, Micro and Nanotechnology Department and currently is a Ph.D. student in University of Illinois at Chicago. She is working in the area of biosensing and surface science.

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A glucose biosensor prepared with graphene based composites

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[3]Northwestern University, USA

We synthesized graphene (GR) based composite such as TiO_2/GR and Pd/GR for glucose biosensor. The GR based composite was fabricated from a colloidal mixture of TiO_2 nanoparticles or aqueous solution of paladium chloride (PdCl2) and graphene oxide (GO) sheets via an aerosol spray pyrolysis (ASP) that is a very fast and continuous process to fabricate the composites as one-step process without reduction reagents. The effect of the precursors content in the colloidal mixture on the composite property, including the morphology, crystal structure and specific surface area was investigated. The particle morphology of all TiO_2-GR composites was spherical in shape and micron-sized TiO_2 particles were encapsulated by GR nanosheets. The morphology of Pd/GR was the shape of a crumpled sheet of paper and the average size of the composite was around 1.3 μm in diameter. The amperometric responses of the glucose biosensors based on the composites were linear against a concentration of glucose ranging from 0 to 8 mM at -0.6 V. The fabricated glucose biosensor based on the Pd-GR composite showed high catalytic performance for glucose redox than the TiO_2-GR biosensor.

Biography

Hee Dong Jang is currently a distinguished researcher and a director of Rare Metals Research Center of Korea Institute of Geoscience and Mineral Resources. He received Ph.D. (1993) from Sogang University in Korea, and Ph.D. (2005) from Hiroshima University in Japan. He earned his postdoc at the University of California at Los Angeles (1996-1997) and visiting scholar at the Northwestern University (2009-2010) in US. He is currently a vice president of Korea Association for Aerosol and Particle Research (2010-present), and an Executive editor of Advanced Powder Technology (2009-present).

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Dissolvable bridges for manipulating fluid volumes in porous membrane networks

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[3]Northwestern University, USA

Porous membrane-based lateral flow assays are used to diagnose many conditions in limited-resource settings due to their low cost and user-friendly format. However, commercial lateral flow assays typically only run single-step processes that may lead to inaccurate results for low concentration analytes. Our goal is to create more sophisticated assays that can perform automated multi-step processes to achieve higher sensitivity detection. In order to achieve this goal, porous fluidic valves for the precise regulation of fluid flow in these devices are needed. We have developed a simple shut-off valve that passes a well-defined volume of fluid before permanent shut-off. These dissolvable bridges offer a way to automate the metering of reagent volumes that would otherwise require the user to pipet exact volumes into the device. We have characterized the operation of the valves and demonstrated their tunability using parameters such as geometry and composition of the dissolvable bridge. In addition, we have demonstrated the utility of dissolvable bridges in the important context of automated delivery of multiple volumes from a common source to different locations in an assay for simple device loading and activation. Dissolvable bridges have the potential to help bring advanced testing using porous membrane networks to limited-resource settings.

Biography

Jared Houghtaling is an undergraduate junior in the Bioengineering Department at the University of Washington. He has spent two years working on point-of-care diagnostics development in the Fu lab. He is a co-author on several publications in the field. Following his undergraduate studies, Jared plans to pursue a Ph.D. in bioengineering.

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Synthesis of iron oxide nanoparticles using different stabilizers and study of their size and properties

Mohammad Hassan Ramezanzadeh and M. Zharnikov
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Magnetic nano particles of ferric chloride were synthesised using a co-precipitation technique. For the optimal results, ferric chloride at room temperature was added to different surfactant with different ratio of metal ions/surfactant. The samples were characterised using Transmissionelectron microscopy, X-ray diffraction and Fourier transform infra red spectrum to show the presence of nano particles, structure and morphology. Magnetic measurements were also carried out on samples using a Vibrating Sample Magnetometer. To show the effect of surfactant on size distribution and crystalline structure of produced nano particles, surfactant with various charge such as: anionic cetyltrimethyl ammonium bromide (CTAB), cationic sodium dodecyl sulphate (SDS) and neutral TritonX-100 was employed. We obtained that by changing the surfactant and ratio of metal ions/surfactant the size and crystalline structure of these nano particles were controlled. We also show that using anionic stabilizer leads to smallest size and narrowest size distribution and the most crystalline (polycrystalline structure).

In developing our production technique, many parameters were varied. Efforts at reproducing good yields indicated which of the experimental parameters were the most critical and how carefully they had to be controlled. The conditions reported here were the best that we encountered but the range of possible parameter choice is so large that these probably only represent a local optimum. The samples for our chemical process were prepared by adding 0.675 gms ferric chloride ($FeCl_3$, $6H_2O$), to three different surfactant in water solution. The solution was sonicated for about 30 min till transparent solution achieved. Then 0.5 gms sodium hydroxide (NaOH) as a reduction agent was poured to the reaction drop by drop which resulted to participate reddish brown Fe_2O_3 nanoparticles, after washing with ethanol the obtained powder was calcinated in 600°C for 2hrs. Here the sample 1 contained CTAB as a surfactant with ratio of metal ions /surfactant 1/2, sample 2 with CTAB and ratio 1/1, sample3 with SDS and ratio 1/2, sample 4 SDS 1/1, sample 5 is triton-X-100 with 1/2 and sample 6, triton-X-100 with 1/1.

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The effect of magnetic field on synthesis of magnetic iron oxide nanoparticles

Milad Kazemihesar and Mohammad Hassan Ramezan zadeh
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Iron oxide nanoparticles have many applications in magnetic storage devices, catalysis, sensors, high-sensitivity biomolecular magnetic resonance imaging (MRI), pigments in dental composites and so on. They are biocompatible and are non-toxic to human body. Co-precipitation, Micro-emulsions and High-temperature decomposition of organic precursors are more important methods of synthesis of iron oxide nanoparticles. We are interested in synthesis of iron oxide nanoparticles by Coprecipitation method. We solve FeCl3 and FeCl2 in distilled water and to gain small particles we add two surfactants named CTAB and SDS to solution. After that we gutty add ammoniac to our solution to sediment of the sample until PH becomes 7. After washing the sample with distilled water and drying it, we characterize the sample by Fourier transform infra red spectrum (FT-IR), X-ray diffraction (XRD), Transmission electron microscopy (TEM), Vibrating sample magnetometer (VSM) and after that we repeat this experiment in presence of magnetic field with determined magnitude and study the effect of magnetic field on the size distribution and properties of these nanoparticles.

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Complex sculpturing 3D DNA nanostructures on protein repelling matrix using electron beam chemical nanolithography

M Nuruzzaman Khan and M. Zharnikov
University of Heidelberg, Germany

As a holder of genetic information and due to its unique hybridization properties, deoxyribonucleic acid (DNA) represents a key object in modern science and related technology. Here we present a universal two-step procedure to fabricate mixed ssDNA/OEG-AT monolayers and 3D patterns on gold substrates with a greater precision and accuracy using Irradiation Promoted Exchange Reaction and E-Beam lithography. The orientation and ordering of DNA in the one-component A25SH monolayer and mixed ssDNA/OEG-AT monolayers was investigated by near-edge X-ray absorption fine structure (NEXAFS) spectroscopy, which proved a significant control of upright orientation of the DNA strands in both systems. The versatility of this approach is demonstrated by its combination with TdT-catalyzed SIEP that allows amplification of ssDNA/OEG-AT patterns in the z-direction. This combination provides a new method to sculpt complex 3D DNA nanostructures on solid supports. Then DNA system was successfully applied for hybridization with the complementary DNA segment and check for its broad range of activity. SAMs, homogeneous poly (A) brushes, and poly (A) nanostructures were characterized by laboratory and synchrotron-based PE spectroscopy, ellipsometry, atomic force microscopy (AFM), and optical microscopy. This system can be widely used as versatile functional moiety and nanoscale building block in such important fields as bio-engineering, bio-sensing, bio-nanotechnology, gene therapy, drug delivery, nanomedicine, and molecular biology.

Biography

M. Nuruzzaman Khan is working as a Ph.D. researcher at the Department of Applied Physical Chemistry, University of Heidelberg under DAAD post graduate fellowship. He was a Research Assistant at the Institute of Radiation and Polymer Technology, Bangladesh Atomic Energy Commission, Bangladesh from 2008 to 2010. He has completed his M.Sc. degree from University of Dhaka, Bangladesh. His research interests are fabrication of ssDNA array, complex 3D-nanopatterning, lithography and synthesis of stimuli responsive polymer. He has published more than 7 papers in international peer reviewed journals including one in *Angewandte Chemie* Int. Ed and serving as a reviewer in reputed journals.

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Biosensor approaches to determination of L-arginine in foods and clinical samples

Ashish Kumar Singh and Neelam Verma
Punjabi University, India

Today's biosensor technology applied as a most promising tool for analytical purpose. In this contest, we focus on biosensing approaches for determination of L-arginine. L-arginine, which is found in most proteins in our daily diet, has been considered the most potent nutraceutical ever discovered, due to its powerful healing properties, and is being referred to by scientists as the Miracle Molecule. The two most major part of the biosensor that need to be optimized, one is the immobilization of biological components and other is the relevant transducer. From many literatures, we have found co-immobilization of two enzymes such as arginase and urease used for the detection of L-arginine. In this, the final product is ammonia, so it can be detected by using such kind of transducer as: pH sensing electrode, ammonia gas sensing, ammonium ion-selective, conductometric and amperometric electrodes are applied. Critical significance of this review is the fact that L-arginine in foods is used as a flavor-providing agent, detection is important as a control measure for quality ensure in foods such as beverages, juices and wine. The dietary sources of L-arginine include red meat, nuts, spinach, lentils, whole grains, soy, sea foods and eggs etc. Other more importants in human physiology with the enormous inherent versatility of L-arginine in various pathways, involved with normal growth and maintenance of the body. The estimation of L-arginine takes place through its metabolic products such as urea, ornithine and citrulline. L-arginine is a precursor of several important intermediates so its determination is imperative as a marker for several diseases.

Biography

Ashish Kumar Singh is a Ph.D. student of Biotechnology at Punjabi University Patiala, Punjab, India. He has more than 7 publications in reputed journals. His current research interests include biosensor development for food quality and clinical applications.

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Detection of saxitoxin using oligonucleotide as sensing element and organic dye as reporter part

Bin Zheng and Michael Hon Wah Lam
University of Science and Technology of China, China

Saxitoxin is a neuron toxin which can block the sodium channel interfering the sodium reflux. It can induce paralysis or even death. It has bioaccumulation effect and cannot be easily get rid of by simple baking. Therefore, the detection of saxitoxin is in great need. Through the study of interaction between designed oligonucleotide and saxitoxin in both structural and thermodynamic ways, we found out that the existence of saxitoxin can effectively interfere the formation of oligonucleotide using organic dye, the concentration of saxitoxin can be indirectly reflected. This method offers simple preparation and easy operation and has the potential application in daily life usage.

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Technology for recognition of unspoken small vocabulary by evaluating features of facial EMG

Dinesh Bhatia
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The most significant part of the human body is the face. The human face acts as an interface to exchange important information with other humans and nature. The spoken language is the most common and best way of communication among humans. Human speech has been examined in scientific and medical research for over 150 years and a focus of research today because of its importance in voice recognition technology and speech prostheses for people who have speech impairments. A novel technique for the feature evaluation using facial EMG during spoken and unspoken modes by subjects (n=20, 11 males and 9 females) is proposed. These features are extracted from the raw EMG signals of four facial muscles that are important in speech production (zygomaticus major, orbicularis oris infer ior, levator labii superioris, anterior belly of diagastric) using commonly employed signal processing (root mean square) values. These values represent the relative activity of the four muscles during speech production. The orbicularis oris inferior (OOI) muscle had significantly greater activation during spoken and unspoken modes of speech compared to the other three muscles. It was also significantly more active in females than in males in spoken and unspoken speech. Further, the fast Fourier transform (FFT) was used to validate and verify the results obtained. From these results, it can be concluded that the OOI is the most active muscle during speech production. Therefore, it should be targeted for the development of speech recognition technology, speech-enabled brain machine interfaces, and speech prostheses for persons suffering from speech impairment. Possibilities for future work include the extraction of speech related features using advanced signal processing techniques like wavelets, neural networks and principal component analyses.

Biography

Dinesh Bhatia pursued his Ph.D. in Biomechanics and Rehabilitation Engineering from MNNIT, Allahabad, India. He is employed as an Assistant Professor (Sr. Grade) at the Biomedical Engineering Department, Deenbandhu Chhotu Ram University of Science and Technology, Murthal (Sonepat), Haryana, India. He was selected as "young scientist" by govt. of India in 2011 to pursue further research at Adaptive Neural Systems Laboratory, BME Department, Florida International Univ., Maimi, USA. He has research papers in several reputed journals with teaching and research experience of more than 09 years. His research focuses on understanding muscle mechanics, joint kinematics and dynamics involved in performing locomotion and routine tasks and undermining its effects during an injury or disease.

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Selective detection of gaseous ammonia with specifically functionalized silicon photonic Microring resonator: Towards low cost and portable breath sensors for point-of-care applications

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In the past five years, silicon photonics for on-chip biomedical and environmental sensing has gained an increasing research interest. A growing need in mass fabricated detection tools in the health care, the environmental and industrial sectors has been a major drive for silicon photonic sensors. Apart from biomolecule detection in the liquid phase, silicon photonic sensors for a range of gas sensing applications are being explored recently. One of the areas integrated gas sensors can have a major impact is point-of-care diagnostics in the health care sector. The detection of exhaled gaseous compounds is expected to have a key role in patient diagnosis and continual health monitoring. For instance, breath ammonia detection has recently attracted a considerable interest as a non-invasive and real-time technique for monitoring patients under dialysis treatment. We report a selective detection of gaseous ammonia using a silicon photonic microring resonator (MRR) functionalized with acidic nanoporous aluminosilicate films. The sensor shows fast, reversible, and selective response to NH_3 with respect to an important interfering gas, CO_2. The sensor can detect below 5 ppm NH_3. Significant improvement in the detection limit can be achieved by tailoring the surface properties of the nanopororous NH_3 sensitive films. The capability to specifically and rapidly detect gaseous compounds on optical chips, as demonstrated here, sheds a light on the future of low cost and highly portable silicon photonic sensors for complex gas analysis in various challenging applications. Such a selective sensor in a CO_2 rich environment paves a way towards a low cost point-of-care device for breath NH_3 detection.

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Direct evidence of advantage of using nano-sized zeolite beta for ISFET based biosensor construction

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Analytical characteristics of urease and butyryl cholinesterase based ISFET (ion sensitive field effect transistor) biosensors were investigated by the incorporation of zeolite Beta nanoparticles with varying Si/Al ratio. The results obtained by the zeolite modified ISFET transducers suggested that the Si/Al ratio strongly influenced the biosensor performances due to the electrostatic interactions between enzyme, substrate, and zeolite surface as well as the nature of the enzymatic reaction. Using relatively small nanoparticles (62.7 ± 10 nm, 76.2 ± 10 nm, and 77.1 ± 10 nm) rather than larger particles, that are widely used in literature, allow us to produce more homogenous product which will give more control over the quantity of material used on the electrode surface and ability to change solely Si/Al ratio without changing other parameters such as particle size, pore volume and surface area. This should enable the investigation of the individual effect of changing acidic and electronic nature of this material on the biosensor characteristics. According to our results, high biosensor sensitivity is evident on nanosize and sub-micron size particles, with the former resulting in higher performance. The sensitivity of biosensors modified by zeolite particles is higher than that to the protein for both types of biosensors. Most significantly, our results show that the performance of constructed ISFET type biosensors strongly depends on Si/Al ratio of employed zeolite Beta nanoparticles as well as the type of enzymatic reaction employed. All fabricated biosensors demonstrated high signal reproducibility and stability for both butyrylcholinesterase (BuChE) and urease.

Biography

Esin Soy has completed her M.Sc. degree at the age of 25 years from Middle East Technical University, Micro and Nanotechnology Department and currently is a Ph.D. student in University of Illinois at Chicago. She is working in the area of biosensing and surface science.

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Amperometric protein biosensing on nanostructured polyaniline (n-PAni) substrate

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Conducting polymers have been widely used in the development and fabrication of biosensors for several applications. This is attributed to their peculiar physical, optical and electrical properties. Polyaniline (PAni), because of its extraordinary stability, simplicity of synthesis and excellent electrochemical properties is one of the most investigated conducting polymers for such applications. PAni based sensors function for amperometric measurements as well as for piezoelectric immunosensing. PAni based amperometric biosensors can be developed on noble metal electrodes such as Au and Pt etc. Currently nanostructures are being used for signal amplification to achieve better sensitivity in sensors. In this paper we have explored the nanostructure form of PAni (n-PAni) to facilitate the immobilisation of a large number of biomolecules as n-PAni has provided improved surface-to-volume ratio. This is found to enhance the sensitivity and response time. n-PAni has been electrochemically deposited on a silicon (Si) substrate to form thin nanostructured films. The film was modified with avidin, followed by immobilization of biotinylated anti-human IgG. Deposited PAni thin films on the Si substrate have been characterized by electron and atomic force microscopy. Successful immobilization of the biomolecules has been confirmed by Raman spectrometric studies. The current–voltage characteristics of the prepared sensor are exploited for the determination of human IgG antigen in the concentration range of 5–550 μg mL−1. The proposed biosensor's detection limit and sensitivity are 5 μg mL−1 and 0.15 μS ppm−1 human IgG, respectively.

Biography

Parveen Kumar is working in the division of nanoscience and nanotechnology in central scientific instruments organisation of council of scientific and industrial research, India. Presently he is working on the immunosensing of breast cancer. His research interests are in the fields of biochemistry, nanotechnology and molecular biology. He has several research publications to his credit.

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