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A0L-A

Plenary Talk 1

9:40 AM - 10:30 AM, April 18, 2016 Room A (FUJI, 1F)

Masaaki Tanemura, Nagoya Institute of Technology (Chair)

Takahito Ono, Tohoku University (Co- Chair)

Paper ID : A0L-A-1

2D Materials: science and technology.....N/A

Antonio H. Castro Neto

Director, Centre for Advanced 2D Materials and Graphene Research Centre, Distinguished Professor, Department of Physics, Professor, Department of Electrical and Computer Engineering, Professor, Department of Materials Science Engineering, National University of Singapore

Over the last five years the physics of two-dimensional (2D) materials and heterostructures based on such crystals has been developing extremely fast. From one hand, with new 2D materials, more and more truly 2D physics started to appear (Kosterlitz-Thouless (KT) behaviour, 2D excitons, commensurate-incommensurate transition, etc). From another - we see the appearance of novel heterostructure devices - tunnelling transistors, resonant tunnelling diodes, light emitting diodes, etc. Composed from individual 2D crystals, such devices utilise the unique properties of those crystals to create functionalities which were not accessible to us in other heterostructures. In this talk I will review the properties of novel 2D crystals and how those properties are used in new heterostructure devices.

A1L-A

Micro-fluidics and Nano-fluidics 1

10:50: AM - 12:25 PM, April 18, 2016 Room A (FUJI, 1F)

Hiroaki Takehara, Nara Institute of Science and Technology (NAIST) (Chair)

Takanori Ichiki, University of Tokyo (Co-Chair)

Paper ID : A1L-A-1 (#1351)

INVITED TALK

Practical Microfluidic Devices for High Sensitive and Low-Cost Analysis in Biomedical and Environmental Fields.....N/A

Yuzuru Takamura

Japan Advanced Institute of Science and Technology, Japan

One of the critical issues for practical application is cost-effectiveness. We are developing simple and low-cost microfluidic devices for biomedical and environmental application. One is an automated paper device for sequential multistep sandwich enzyme-linked immunosorbent assays (ELISA). It is fabricated on a piece of nitrocellulose membrane, having several solution pathways (channel) separated by barrier-lines and amount of the reagents pre-spotted on the pathways. It can process the multi steps of mixing, incubation, washing, and substrate application required for enzyme enhancement immunoassay by just dipping a piece of paper device into sample solution. Another one is a high-sensitive ultra-compact elemental analyzer utilizing a micro channel whose center is made narrower. When the sample solution is introduced into the channel and a voltage (800~1500 V) is applied from the both ends, we can know the element concentration with high-sensitivity from the emission spectra of the discharge generated at the center narrow part of the channel. This method requires neither plasma gas nor nebulizer, and is very compact and simple. The limit of detection for Cd and Pb were derived as 0.5 ppb and 5 ppb, respectively in 0.1 M HNO_3. Those values is low enough for the environmental analysis applications.

Keywords - POCT, microfluidics, lab on paper, micro plasma

Paper ID : A1L-A-2 (#1274)

INVITED TALK

Microfluidic-Based Diagnostic Device for Early Cancer Detection.....N/A

Takanori Ichiki
University of Tokyo, Japan

In order to overcome cancer and other intractable diseases, we need to create a seamless, comprehensive process where the heralding signs and lesions of diseases are precisely detected by early diagnosis via screening and by accurate diagnosis using imaging techniques, highly effective and safe treatment is provided by combining surgeries as topical treatments and drug therapies as systemic treatments based on the condition of the disease, and the lesion is reconstructed after treatment. In recent years, our group has been developing an innovative cancer diagnostic device that integrates all the steps of time-consuming blood test on a single cartridge, which comprises separation, purification and sensitive detection of biomarkers in the body fluid such as serum or urine. In this development, we have chosen the strategy to use circulating miRNA, stabilized by encapsulation in exosomes, as a cancer biomarker. I will present our recent results on the development of the miRNA diagnosis system, and show a prospect that the time required for the diagnosis can be greatly shortened to less than one hour by the recent progress in nanobiodevice technology.

Keywords - Diagnostic device, Microfluidics

Paper ID : A1L-A-3 (#1127)

A Self-Driven Microfluidic Chip Through a Rapid Surface Modification of PDMS and its Application for Digital Loop-Mediated Amplification (LAMP).....1

Yu-Dong Ma{4}, Wen-Hsin Chang{4}, Chih-Hung Wang{4}, Shih Yuan Liu{1}, Wen Hsiang Yen{1}, Kang Luo{4}, Huey-Ling You{2}, Jiunn-Jong Wu{3}, Mel S. Lee{2}, Gwo-Bin Lee{4}
{1}Coretronic Corporation, Taiwan; {2}Kaohsiung Chang Gung Memorial Hospital, Taiwan; {3}National Cheng Kung University / National Yang-Ming University, Taiwan; {4}National Tsing Hua University, Taiwan

Digital loop-mediated amplification (LAMP) is an isothermal, quantitative DNA amplification approach which has high sensitivity and specificity and could be used to analyze extremely low amount of DNA within a short period of time. In this study, an integrated self-driven microfluidic chip was proposed herein for performing a digital LAMP for vancomycin-resistant enterococcus (VRE) diagnosis. The entire bacterial diagnosis could be automatically performed by capillary forces through the new polydimethylsiloxane (PDMS) surface treatment without external pumps. Moreover, digitized droplets could be separated from each other by normally-close valves such that it could be quantized. The hydrophilicity of the treated PDMS surface was measured to be 24° by contact angle measurement, which was the lowest value in literatures. This is the first time that a rapid (within 1 hour), simple, and hydrophilic PDMS surface modification method has been reported, which could be used in self-driven microfluidic devices for digital LAMP. This device may become a promising tool for clinical diagnosis and point-of-care applications.

Keywords - digital LAMP, VRE, PDMS modification, microfluidics

Paper ID : A1L-A-4 (#1242)

Study of Reprogramming Using on-Chip One-to-One Electrofusion of Somatic Cells with Embryonic Stem Cells.....N/A

Shota Sakamoto{2}, Kennedy Okeyo{2}, Osamu Kurosawa{2}, Hidehiro Oana{2}, Hidetoshi Kotera{1}, Masao Washizu{2}
{1}Kyoto University, Japan; {2}University of Tokyo, Japan

To observe reprogramming of somatic cells by fusion, we fused somatic cells with embryonic stem cells (ESCs) using on-chip one-to-one electrofusion device and cultured the resulting fusants on a BSA (bovine serum albumin)-patterned floor to monitor their behavior using timelapse microscopy. We observed cell division and the expression of Oct 4-GFP reporter within 24 hours after fusion, suggesting that cell reprogramming commence earlier than previously reported.

Keywords - Reprogramming, Electrofusion

Paper ID : A1L-A-5 (#1250)

Flow Control of a Microfluidic Device for Studying Vascular Network Morphology.....N/A

Masamune Nakayama{2}, Yuji Nashimoto{2}, Itsuki Kunita{1}, Akiko Nakamasu{3}, Yu-Suke Torisawa{2}, Hirofumi Shintaku{2}, Hidetoshi Kotera{2}, Koichi Nishiyama{1}, Takashi Miura{3}, Ryuji Yokokawa{2}
{1}Kumamoto University, Japan; {2}Kyoto University, Japan; {3}Kyushu University, Japan

A vascular network reconstituted in a microfluidic device is advantageous in studying its morphology in vitro. Here, we quantitatively evaluated liquid flow velocity in a microfluidic device filled with fibrin gel and vascular network. The microfluidic device was fabricated by a conventional poly-dimethylsiloxane (PDMS) soft lithography, and human umbilical vein endothelial cells (HUVECs) and normal human lung fibroblasts (LFs) were co-cultured to create a vascular network. With or without fibrin gel and the vascular network, we measured flow velocity by particle image velocimetry (PIV) and fluorescence recovery after photobleaching (FRAP). Numerical simulation results also supported these quantitative experimental results. We found the velocity distribution was strongly influenced by the shape of the device structure without gel, however, the velocity was uniform within gel in the same microfluidic device.

Keywords - microfluidic device, vascular network, vasculogenesis, flow veloc

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A1L-B

Integration & systems

10:50 AM - 12:25 PM, April 18, 2016 Room B3 (CHIYO 3, 1F)
Honglong Chang, Northwestern Plytechnical University (Chair)
Masanori Muroyama, Tohoku University (Co-Chair)

Paper ID : A1L-B-1 (#1231)

INVITED TALK

Low Temperature Wafer Bonding for Heterogeneous Integration.....N/A

Joerg Froemel{1}, Shuji Tanaka{2}, Masayoshi Esashi{2}, Thomas Gessner{1}
{1}Fraunhofer Institute for Electronic Nano Systems ENAS, Germany; {2}Tohoku University, Japan

The low-temperature bonding of semiconductor wafers is an important technology for 3D integration and other heterogeneous integration schemes. In this contribution we will give a review about existing possibilities like for example thermocompression bonding and reactive bonding. Furthermore a near room temperature bonding process by solid liquid inter-diffusion (SLID) bonding using the Cu/Ga system will be explained and shown in detail. The bonding by Ga SLID has been investigated regarding the bonding parameters and their influence on bond interface properties. The focus is on temperature dependence and composition of interface. In the case of Cu/Ga bonding, a phase transition from $CuGa_2$ to Cu_9Ga_4 was found to be primarily responsible for an increase in bonding strength. After the temperature treatment of 90°C, a shear strength of up to 90 MPa and hermetic bond could be achieved.

Keywords - wafer bonding, low temperature, gallium alloys, SLID

Paper ID : A1L-B-2 (#1144)

INVITED TALK

Massive Parallel Electron Beam Direct Write (MPEBDW).....N/A

Hiroshi Miyaguchi{1}, Akira Kojima{1}, Naokatsu Ikegami{1}, Masanori Muroyama{1}, Shinya Yoshida{1}, Nobuyoshi Koshida{2}, Masayoshi Esashi{1}
{1}Tohoku University, Japan; {2}Tokyo University of Agriculture and Technology, Japan

Nanoscale lithographic technologies have been studied for the next generation semiconductor manufacturing practices. While mask-less/direct-write electron beam (EB) lithography methods serve as a candidate for the 10-nm node and beyond, it remains difficult to achieve an appropriate throughput level. Several multiple EB systems using a thermionic source have been proposed. However, a blanking array is required to switch multiple beamlets individually: by deflecting onto or passing through the array. We use a 100 x 100 emitter array which includes nanocrystalline-Si (nc-Si) ballistic electron emitters. Electrons are drifted via

multiple tunnelling cascade transport and are emitted as hot electrons. The emitter allows high-speed electron beamlets switching. The emitter array is fabricated by MEMS technology, and hetero-integrated with a CMOS LSI which drives the emitter array as an active-matrix. Each emitted beamlet (10 x 10 μm^2) is converged to 10 x 10 nm^2 on a target via a reduction electron optics. We will present our Massively Parallel Electron Beam Direct Write system, and overview the system and characteristic of the nc-Si emitter array.

Keywords - nanocrystalline Si, electron emitter array, electron beam lithography, direct write lithography, multiple electron beams

Paper ID : A1L-B-3 (#1221)

Development of Optically Controlled Field Emitter Array with Integrated Gate Electrode.....5

Toya Kera, Norihiro Umeda, Kentaro Iwami
Tokyo University of Agriculture and Technology, Japan

A field emitter array (FEA) with integrated gate electrode was fabricated on a transparent substrate for optical control. An array consisting of about 30000 emitters is disposed in ϕ3 mm area on a quartz-glass substrate. I"V characteristics of the FEA were measured and the emission regime was confirmed as field emission from Fowler-Nordheim analysis. The results obtained from this study are expected to be applied for optically controlled field emitter array.

Keywords - FEA, Field Emission, EBL, MEMS, plasmon

Paper ID : A1L-B-4 (#1195)

Programmable Micro System for Smart Blasting Network.....9

Yunlong Guo, Wenzhong Lou, Xuran Ding, Peng Liu
Beijing Institute of Technology, China

We present a high accuracy, high reliability, high security, low power consumption micro blasting system for smart blasting network. The system consists of a MEMS semiconductor bridge (SCB) as electro-pyrotechnic initiator to ignite the explosive materials, a MEMS switch group as security device to increase the security, a micro application-specific integrated circuit (ASIC) as controller to control all the components and a streamlined peripheral circuit. The system is particularly suitable for accurate directional blasting at large surface and underground operations or other complex environments.

Keywords - Micro Blasting System, MEMS,SCB, MEMS Switch Group, ASIC

Paper ID : A1L-B-5 (#1265)

Monolithic Fabrication of NiW Alloy Absorber/ Emitter for Thermophovoltaic Power Generation.....N/A

Na Shun, Masahiro Kagimoto, Norihiro Umeda, Kentaro Iwami
Tokyo University of Agriculture and Technology, Japan

This paper reports on a novel monolithic fabrication process of a solar light absorber and selective thermal emitter for thermophotovoltaic power generation (TPV). Metallic microcavity structure made of heat-resistive NiW alloy is adopted to modify spectral emissivity of both absorber and emitter. A free-standing NiW thin film which has microcavities on its both sides with different dimensions is fabricated through two-step deep reactive ion etching of silicon, NiW electroplating, and silicon lost molding. The fabricated NiW film exhibits different spectral emissivities between both sides.

Keywords - SPTV, microfabrication, electroplating, NiW, emissivity

A1L-C

Nanomaterials 1

10:50 AM - 12:25 PM, April 18, 2016 Room C (HAGI, 1F)

Liqiang Mai, Wuhan University of Technology (Chair)

Hirokazu Fukidome, Tohoku University (Co-Chair)

Paper ID : A1L-C-1 (#1174)

INVITED TALK

Nanowire Devices for Electrochemical Energy Storage.....N/A

Liqiang Mai

Wuhan University of Technology, China

One-Dimensional nanomaterials with large surface area, more surface active sites and better permeability can significantly increase the energy density, power density and cycling performance for the energy storage. Such hierarchical structure can also be used as targeted intracellular recording for its facile synthesis route. In our present work, a series of hierarchical nanomaterials have been obtained, including kinked hierarchical nanowires, hierarchical heterostructured nanowires and hierarchical scrolled nanowires which shows great electrochemical properties.

Keywords - Nanowire, Electrochemical, Nanomaterials, Supercapacitors

Paper ID : A1L-C-2 (#1327)

INVITED TALK

Self-Assembled Hierarchical Materials with High Activity and High Stability.....N/A

Xiaoyu Yang, Jie Ying, Yu-Xuan Xiao, Hao Wei

Wuhan University of Technology, China

Self-assembled nanomaterials, which are formed from interatomic and intermolecular interactions, may represent building blocks in the 21st century. The most significant problems with the applications of these nanomaterials have been property changes over time duo to poor stability. Recently advances in selfassembly technique enabled precise control synthesis of nanomaterials, which has significant impacts in the development of self-assembled nanomaterials.

Keywords - Nanomaterials, Nanocrystals, Self-assembly

Paper ID : A1L-C-3 (#1134)

Crystal Orientation Dependence of Piezoresistivity for VLS-Grown Single Crystal Silicon Nanowires.....N/A

Shinya Nakata{1}, Yuma Kitada{1}, Stefan Wagesreither{2}, Alois Lugstein{2}, Koji Sugano{1}, Yoshitada Isono{1}

{1}Kobe University, Japan; {2}Technische Universität Wien, Austria

This research clarified the piezoresistance effect of individual single crystal silicon nanowires (SiNWs) under uniaxial tensile strain using a MEMS-based strain engineering device. The intrinsic SiNWs with a length of 3 microns and a diameter of 100 nm in nominal were monolithically integrated in the MEMS devices using Vapor-Liquid-Solid (VLS) technique. The SiNWs were synthesized in crystal orientations of <111> and <112>. The MEMS device is able to apply uniaxial tensile strain to SiNWs by the electrostatically driven comb actuator, and to measure simultaneously the tensile displacement using the mechanically amplification system. We have succeeded in clarifying the crystal orientation dependency of mechano-electric characteristics of SiNWs. From stress-strain curves for SiNWs grown in the direction of <111> and <112>, Young's moduli showed 189.2 and 162.7 GPa, respectively. The electrical properties of SiNWs resulted in 5-fold and 1.53-fold increases in conductivity for the <111>-grown SiNW and the <112>-grown SiNWs, respectively, at 3 % strain. The gauge factors also showed -170.7 at 0.2 % for <111>-grown SiNWs and -128.9 at 0.1 % for <112>-grown SiNW, respectively.

Keywords - Vapor-liquid-solid CVD, single crystal silicon nanowire, stress-strain relation, piezoresistance

Paper ID : A1L-C-4 (#1179)

Controlled Assembly of Nanosilver Particles Inside Bacterial Cell Scaffold.....14

Lili Sun, Deyuan Zhang, Jun Cai
Beihang University, China

We present a straightforward technique to fabricate helical particles embedded with nanosilver particles aggregation using Spirulina platensis as scaffold, during which the nanosilver particles were controllably synthesized inside the biotemplate by the electroless deposition technique. The TEM of the as-prepared micro particles showed that nanosilver particles were universally distributed inside the biotemplate. The size of the intracellular nanosilver particles can be adjusted by controlling the reaction time. Helical particles prepared using this method are stable in deionized water. The intracellular synthesis mechanism of silver nanoparticles was analyzed. This technique can be generalized to other microorganism templates and different deposition materials that can be synthesized by electroless deposition technique. And the achieved highly-ordered nano particle aggregations have promising applications in various fields, such as nanocatalyst, wastewater treatment, bio-medicine and anti-microbial materials.

Keywords - nanosilver particles, intracellular synthesis, electroless deposition, Spirulina platensis, biotemplate

Paper ID : A1L-C-5 (#1262)

Mechanical Stability for the Connections of DNA Origami Using Anti-Parallel/ Parallel Double Crossovers.....N/A

Zhipeng Ma{1}, Seongsu Park{1}, Naoki Yamashita{1}, Kentaro Kawai{2}, Do-Nyun Kim{3}, Yoshikazu Hirai{1}, Toshiyuki Tsuchiya{1}, Osamu Tabata{1}
{1}Kyoto University, Japan; {2}Osaka University, Japan; {3}Seoul National University, Korea, South

DNA origami is increasingly attractive for the construction of large scale architecture that can arrange a variety of nanoscale materials into ordered structure with high complexity and functionality, but utilization as a functional mechanical component depends on understanding crucial properties such as the mechanical stability for their connections that has rarely been studied. Here, we report a study of mechanical stability measurement of an orientation-controlled array of connected DNA origami with different connection strategies. The anti-parallel double crossovers were used for the connection of DNA origami with same surface orientation, while the parallel double crossovers were for the connection of DNA origami with alternating surface orientations. The mechanical stability for them against probe compression was revealed by force-distance mapping using atomic force microscopy.

Keywords - DNA origami, Mechanical stability, Atomic Force Microscopy

A1L-D

Nano-biology and informatics

10:50 AM - 12:25 PM, April 18, 2016 Room D (TOKIWA, B1F)

Satoshi Konishi, Ritsumeikan University (Chair)

Paper ID : A1L-D-1 (#1361)

INVITED TALK

DNA Aptamer: its Principles and Applications.....N/A

Hisashi Satoh
Hokkaido University, Japan

DNA aptamers are single-stranded DNA molecules that selectively bind to target molecules just as antibodies do. DNA aptamer possess several advantages over antibody. DNA aptamers are easily synthesized chemically at low cost with high reproducibility and their production is independent on animals. They have greater specificity and affinity. They can easily be modified chemically to yield improved properties. Toxicity and immunogenicity are lower. They tolerate pH and temperature changes, yielding a higher shelf life. Many DNA aptamers have been selected for corresponding targets including metal ions, organic molecules, biomolecules, and even microorganisms and cells, relying on their special three-dimensional structures. Aptamers

are screened with a combinatorial technique called systematic evolution of ligands by exponential enrichment (SELEX). SELEX methods have been modified over the years to make aptamer isolation easier, faster and straightforward. DNA aptamers have been studied for research, diagnosis and therapy whereas they have not been applied to environmental monitoring sufficiently. We are trying to develop DNA aptamers for water pollutants, such as human adenovirus and arsenite. DNA aptamers for human adenovirus were enriched in our laboratory while DNA aptamer for arsenite was synthesized based on the previous report. Adenovirus and arsenite concentrations were determined successfully by colorimetry.

Keywords - SELEX, biosensor, heavy metals, pathogenic microorganisms

Paper ID : A1L-D-2 (#1360)

INVITED TALK

Development of Novel Sensing Techniques for Solid-State Based DNA Analysis.....N/A

Steve Tung
University of Arkansas, United States

DNA analysis has become increasingly important as a diagnostic tool for biological and biomedical discovery. In recent years, several new DNA sequencing techniques have been developed to significantly reduce the required sequencing time and cost. Among them, solid-state devices such as nanopores and nanochannels have shown tremendous promises in achieving a true label-free method that does not require extensive sample pre-treatment. However, significant challenges still exit for these new devices to produce reliable sequencing results. For example, the physical dimensions of the sensing elements used in the nanopores and nanochannels are still too large to properly resolve individual DNA bases. The present talk will discuss the latest development in the design and fabrication of novel sensing techniques for solid-state based DNA sequencers. Sensing schemes such as the tunneling current will be compared with alternative approaches such as electrical conductance in terms of sensitivity and ease of implementation. Sensing materials such as the conventional metal nanoelectrodes and the novel graphene nanoribbons will also be discussed. The talk will conclude with a discussion on the application of a single chain of carbon atoms to directly 'read' the DNA bases by monitoring the conductance change in the carbon chain.

Keywords - sensor, DNA analysis

Paper ID : A1L-D-3 (#1208)

Development of High-Speed Angle-Resolved Imaging System for Gold Nanorod and Application to Detection of Conformational Change of Molecular Motor.....N/A

Sawako Enoki{2}, Ryota Iino{1}, Yamato Niitani{2}, Yoshihiro Minagawa{2}, Michio Tomishige{2}, Hiroshi Ueno{2}, Hiroyuki Noji{2}
{1}National Institute of Natural Sciences, Japan; {2}University of Tokyo, Japan

We developed two types of high-speed angle resolved imaging methods for single gold nanorod using objective-type vertical illumination dark-field microscopy at microsecond temporal resolution and one degree precision. One is based on polarized component analysis, and the other is based on the analysis of defocused SAuNR image. Although both methods showed a precision of ~ 1° for azimuthal angle at 10 μs temporal resolution, the defocused image analysis showed better angle accuracy ~5°. In addition to the azimuthal angle, defocused image was also applied to analysis of polar angle by the fit with simulated image with the precision of ~ 1°. As a demonstration of our method applied to the single-molecule study of molecular motors, the rotation of F1-ATPase was measured with 3.3 μs temporal resolution. The time constants of pauses waiting for the elementary steps of the ATP hydrolysis reaction and the torque generated in the mechanical steps have been successfully estimated. Furthermore, conformational change of catalytic subunit β of F1-ATPase, which drive the central shaft γ subunit, was observed. We successfully resolved reversible conformational changes of the subunit β between open and closed states driven by ATP hydrolysis reaction. Our method will be applicable to the monitoring of the fast conformational dynamics of enzymes.

Keywords - gold nanorod, single molecule imaging, molecular motor

Paper ID : A1L-D-4 (#1301)

RNA Hydrogel.....N/A

Zhen Huang{2}, Sangwoo Lee{1}, Li Niu{2}
{1}Rensselaer Polytechnic Institute, United States; {2}University at Albany, State University of New York, United States

Hydrogel is a class of material formed by a hydrophilic polymer network with high water retention capacity. As a material, the property of a hydrogel, such as swelling, permeation, mechanical and optical as well as surface properties, can be modulated for various applications. Biomolecules, such as lipids, peptides, proteins, polysaccharides, and deoxyribonucleic acid (DNA), but not ribonucleic acid (RNA), have been found to form hydrogels. Here we describe an RNA capable of forming hydrogel. The RNA was identified from a ~1014 RNA library using systematic evolution of ligands by exponential enrichment (SELEX). Using a variety of techniques, such as rheology, small angle-X-ray diffraction and using cryogenic electron microscopy, we have characterized, and present here, the property of this RNA hydrogel. By mutational analysis, we have also determined the unique sequence feature that has enabled this particular RNA to form hydrogel.

Keywords - RNA, hydrogel, nanomedicine, glutamate ion channels

Paper ID : A1L-D-5 (#1304)

A Novel Approach to Optimize Combinatory Drugs Using Markov Chain.....18

Bo Wang, Wenxue Wang, Yuechao Wang, Lianqing Liu
Shenyang Institute of Automation, China

Combinatory drugs are often used in clinical medications for treating some complex diseases such as cancer, diabetes, etc. An extreme challenge in combinatory therapy is that the number of combinations will increase exponentially as the types of drugs increase, which makes it very difficult to choose the optimal concentration. In this paper, we present a new algorithm based on the stationary distribution of Markov chain to optimize combinatory drugs. We evaluated the new algorithm by comparing its performance with the other two stochastic algorithms, the Gur Game algorithm and the modified Gur Game algorithm. Numerical simulations clearly show that the algorithm based on Markov chain has a better performance than these two stochastic algorithms, in terms of both reliability and efficiency. This work provides a general method for the combinatorial optimization problem, and it is meaningful for clinical combinatory therapy.

Keywords - Combinatory Drugs, Optimization Algorithm, Markov Chain, Stationary Distribution, Prediction

A1L-E

Molecular Robotics I (International Symposium on Molecular RoboticsCo-sponsored by KAKENHI Molecular Robotics)

10:50 AM - 12:25 PM, April 18, 2016 Room E (SUEHIRO, B1F)

Akihiko Konagaya, Tokyo Institute of Technology (Chair)

Paper ID : A1L-E-1 (#1023)

INVITED TALK

Development of Molecular Robots Equipped with Sensors and Intelligence.....N/A

Masami Hagiya
University of Tokyo, Japan

Molecular robotics is a field of science and engineering that aims to construct molecular robots, which are autonomous systems consisting of sensors, computers and actuators, all realized by molecular devices, and are capable of reacting to the environment by analyzing signals from the environment and making decisions. The research project, whose title is the same as that of this talk and abbreviated Molecular Robotic, is conducted as a grand-in-aid for scientific research on innovative areas in Japan. It aims to open a new research area between chemistry and robotics, where we take the word robotics in a broader sense, including computer science, control engineering, systems science, etc. In this talk, we introduce the research project, and mainly explain its goal and organization of its research teams. Before explaining the project, we also touch upon the history and current trends of related research areas, from which molecular robotics has emerged.

Keywords - Molecular robotics, Molecular computing, DNA computing, DNA nanotechnology

Paper ID : A1L-E-2 (#1118)

INVITED TALK

Development of Molecular Sensor and Device for Intelligent Molecular Robots.....N/A

Hirohide Saito
Kyoto University, Japan

Nucleic acid nanotechnology has a promising outlook in the field of molecular robotics and future therapeutic applications. Our team focuses on how to design and create DNA or RNA-based sensors that detect environmental signals and transmit information to construct “smart” molecular robots. First, we focused on DNA and RNA molecules to build designed nanostructures and functional nanodevices. DNA origami nanostructures were efficiently self-assembled on lipid-bilayer that may be used for constructing functional molecular robots. We also introduce our new technologies, called “RNA switches” and “RNA nanodevices” that function in vitro and in live mammalian cells. Also, we recently constructed “protein-triggered RNA nanodevices” with designed nanostructures and functions. RNA nanodevices could control both their conformations and functions by detecting protein signal as a fuel. Taken together, our approach could provide a new way to construct functional molecular robots that function in vitro and inside of cells.

Keywords - molecular sensor, molecular device, molecular robots

Paper ID : A1L-E-3 (#1011)

INVITED TALK

Collective Behaviors Encoded by DNA.....N/A

Guillaume Gines, Yannick Rondelez
University of Tokyo, France

Molecular programming is inspired by conceptual borrowings from systems biology and supramolecular chemistry. It uses biomolecules as information support and biochemical reactions as computational primitives, in order to build circuits with pre-defined dynamical behaviors. In this context, synthetic DNA oligonulceotides are especially useful because of their simple and predictable base-pairing rules, as well as their wide availability. Moreover, many enzymes can be used to process this informational polymer. Our team has previously developed the Polymerase/Exonuclease/Nickase Dynamic Network Assembly (PEN-DNA) toolbox which provides a programmable way to design artificial molecular devices such as clocks, memories, logic elements using free floating DNA instructions. It uses three enymatic activities and very short DNA instructions. We will discuss recent developement in the spatial implementation of these systems as an approach toward molecular scale swarm robotics.

Keywords - molecular programming, swarm robotics

A2L-A
CM Ho paper award session

1:25 PM - 2:40 PM, April 18, 2016 Room A (FUJI, 1F)

Yuzuru Takamura, Japan Advanced Institute of Science and Technology (Chair) (JAIST)

Paper ID : A2L-A-1 (#1025)

Synthesis of Scalable Micro-Spheres by Plateau-Rayleigh Instability.....24

Gang Fan{3}, Bing Zhang{3}, Chuan-Gui Liu{3}, Shan Tang{3}, Jian Yang{3}, Zhi-Jun Ma{2}, Xianting Ding{1}
{1}Shanghai Jiao Tong University, China; {2}South China University of Technology, China; {3}Zhejiang University, China

In the field of the fabrication of micro- and nano-spheres, the phenomenon of Plateau-Rayleigh instability has drawn more and more attention. This surface tension-driven instability in two immiscible fluids can be used to generate uniformly size micro- and nano-spheres by imposing an external mechanical excitation. In this article, we mainly adopt numerical simulation method to study the effects of wavelength, viscosity and surface tension on Plateau-Rayleigh instability. In addition, a micro-spheres generation system based on controlling the breakup process of the co-flowing jet is studied. The numerical results show that the current method can efficiently control the size of the micro-spheres from a variety of fluids. Also, the effects of amplitude and frequency of the excitation during the fabrication process on the size of micro-spheres are investigated.

Keywords - Plateau-Rayleigh instability,numerical simulation,micro-spheres,co-flowing jet

Paper ID : A2L-A-2 (#1061)

Disposable High Pressure Peristaltic Micro Pump for Standalone and on-Chip Applications.....29

Andreas Loth, Ralf Förster
Beuth Hochschule für Technik Berlin, Germany

A novel disposable high pressure peristaltic micro pump has been developed, which allows a precise dosing of single volumes in the nanoliter range. The tube is integrated into a single use cartridge, which offers numerous advantages. A high pressure can be generated, while a small internal volume gives opportunity to handle expensive or rare fluids. Its small size allows the implementation into biochips or micro fluidic systems. The standalone solution can be connected to semi flexible tubes or pipes. The fluidic properties of the pump and the achievable maximum pressure have been determined. The fatigue resistance of the cartridge has been verified. Its simple structure offers the potential for mass production.

Keywords - peristaltic pump, micro fluidics, modular, disposable, on-chip, LOC

Paper ID : A2L-A-3 (#1080)

Long-Range Electrokinetic Fluid Motion for Rapid Pathogen Identification and Antimicrobial Susceptibility Testing.....N/A

Yi Lu{2}, Siu Ling Leung{2}, Jian Gao{2}, Vincent Gau{1}, Joseph Liao{3}, Pak Kin Wong{2}
{1}Genefluidics, Inc., United States; {2}Pennsylvania State University, United States; {3}Stanford University, United States

This study reports a novel electrokinetic phenomenon that drives long-range (centimeter scale) fluid motion in microfluidic systems for rapid pathogen identification and antimicrobial susceptibility testing. The long-range fluid motion addresses several fundamental challenges in the translation of microfluidics for clinical diagnostic applications, including volume mismatch (e.g., ml to nl), applicability for biological manipulation (from cells to molecules), (3) matrix effects (e.g., blood and urine), and (4) systems integration of different sensing and sample preparation modules. This electrokinetic phenomenon cannot be explained by existing theory of electrokinetics. A combined experimental and computational study reveals the pivotal roles of buoyancy, boundary condition, temperature rise, and associated changes in material properties in the long-range fluid motion. We show the clinical applicability of the long-range fluid motion by in situ assay enhancement on an electrochemical biosensor for pathogen identification and electrokinetic isolation of bacterial pathogens for single cell antimicrobial susceptibility testing from patient-derived samples.

Keywords - Multidrug resistant pathogen, point-of-care diagnostics, antimicrobial susceptibility testing, pathogen identification

Paper ID : A2L-A-4 (#1038) Withdraw

Paper ID : A2L-A-5 (#1278)

Self-Powered Liquid Volume Sensor Aiming at Lab-on-Chip Applications.....34

Hao Wang, Tao Wang, Chengkuo Lee
National University of Singapore, Singapore

Technology for enabling drug delivery with precise control is strongly demanded by patients with diabetes or other chronic diseases. More intelligent functions such as drug loading and delivery in controllable manner without requiring electrical power will make low-cost drug delivery patches come true. One of the promising candidates is triboelectric technology which has been deployed as nanogenerators and self-powered glucose sensors recently. In this paper, the drug delivery is triggered by finger-pressing on a polymer based micropump. Considering that the finger-pressing should be an action of very low frequency, e.g., 1 to 2 Hz, triboelectric energy harvester (TEH) based on contact-separation mode between patterned biocompatible polymer layer and Aluminum (Al) film is integrated with microneedles on a flexible skin patch. Leveraging triboelectric materials and compatible fabrication technology, we successfully develop a self-powered flexible skin patch for transdermal insulin delivery with novel liquid volume sensor to monitor delivered drug volume.

Keywords - Triboelectric liquid volume sensor, drug delivery patch

A2L-B
NEMS/MEMS fabrication
1:25 PM - 3:00 PM, April 18, 2016 Room B3 (CHIYO 3, 1F)
Joerg Froemel, Fraunhofer ENAS (Chair)
Masanori Muroyama, Tohoku University (Co-Chair)

Paper ID : A2L-B-1 (#1356)

INVITED TALK

Three-Dimensional UV Photolithography Using Thick Photoresist for Microsystems.....N/A

Takaaki Suzuki
Gunma University / Japan Science and Technology Agency, Japan

Recently, complex performances and microstructures are required for microsystems with expanse of application fields. There is a limit in two-dimensional layer stacking method based on the conventional semiconductor manufacturing process because the processing process has been complicated with the processing microstructures. Moreover, the improvement of the integration density of micro-components is difficult in the conventional assembly method. In this paper, an assembly-free fabrication process using a three-dimensional UV lithography in combination with rotation and inclination of thick photoresist coated on single mask is introduced. In addition, applications for microsystems are shown in order to confirm the validity of the proposed fabrication process. In the biotechnology field, DNA fiber preparation technique on a chip is demonstrated for clinical diagnosis. As a microactuator, dual-axis hybrid-MEMS mirror having Si and thick photoresist hinges is demonstrated for large-area 2D raster scan.

Keywords - Photolithography, Microstructure, Microsystem, Thick photoresist, Assembly-free

Paper ID : A2L-B-2 (#1357)

INVITED TALK

Thermal Scanning Probe Nanolithography and Nanoparticle Assembly: Complementary Emerging Methods in View of Mass-Customized NEMS.....N/A

Juergen Brugger, Valentin Flauraud, Yuliya Lisunova, Samuel Zimmermann
École Polytechnique Fédérale de Lausanne, Switzerland

Nanopatterning is available in various ways for prototyping and manufacturing. Yet, in order to expend towards mass-customizable NEMS with improved fabrication yield, further progress is needed in the two following areas: a) rapid prototyping

and re-design, and b) cost-efficient up-scaling. Thermal scanning probe lithography (thSPL) has become an increasingly reliable method for rapid prototyping of 2D and quasi-3D structures in polymers, which can be transferred into silicon [1]. Our recent effort has focused on improved process steps to increase the aspect ratio of surface structures in dielectric and semiconducting material to expend their use into e.g. optics, fluidics, etc. [2]. Further progress includes thSPL on transparent substrates [3]. Complementary to thSPL as top-down prototyping, we also investigate how capillary assisted nanoparticle assembly [4] can be used to fabricate nanosystems from bottom-up. Here, we show templated self-assembly of nanoparticles and nanorods with placement and orientation accuracy down to few nm, on cm areas [5]. This method enables for instance improved, large-scale nanophotonic systems to be built at very low cost. The paper will review the state-of-the-art of these two complementary techniques and will present some of our own recent original results.

Keywords - Scanning probe lithography, self-assembly, nanoparticles

Paper ID : A2L-B-3 (#1076)

Fabrication and Characterization of a Novel Electrostatic Actuator.....N/A

Holger Conrad{1}, Bert Kaiser{1}, Matthieu Gaudet{1}, Sergiu Langa{1}, Michael Stolz{1}, Klaus Schimmanz{2}, Harald Schenk{2}

{1}Fraunhofer Institute for Photonic Microsystems, Germany; {2}Fraunhofer Institute for Photonic Microsystems / Brandenburgische Technische Universität, Germany

Todays quasi-static electrostatic micro actuators have significant limitations in deflection due to electrode separation and unstable drive regions. These actuators suffer from an operational instability, the so-called pull-in effect. The maximal travel range is limited to one third of the electrode separation for a quasi-static actuation. High driving voltages and large electrode separation are required to achieve a large actuator displacement. In this work, we present a novel electrostatic and full CMOS-compatible actuator class, which allows high deflections with nanometric electrode separation. The presented approach utilizes a bimorph like effective lever to transform electrostatic forces into deflection. It permits to reach high electrostatic forces within the gap and thus giving access to large actuator deflections. For the first time, quasi-static actuations that are significantly larger than the electrode separation were measured.

Keywords - MEMS, electrostatic actuator, small gap, pull-in, bending actuator, bimorph, sacrificial layer technology, low voltage

Paper ID : A2L-B-4 (#1124)

Flexible Organic Light Emitting Diode Ribbons Using Three Liquid Organic Semiconductors.....38

Atsuki Nobori{3}, Naofumi Kobayashi{3}, Hiroyuki Kuwae{3}, Takashi Kasahara{3}, Juro Oshima{2}, Chihaya Adachi{1}, Shuichi Shoji{3}, Jun Mizuno{3}

{1}Kyushu University, Japan; {2}Nissan Chemical Industries, LTD., Japan; {3}Waseda University, Japan

We propose ribbon type flexible organic light emitting diodes (OLEDs) using liquid organic semiconductors (LOSs), which can be integrated into textiles. Linear flexible structure, which consists of a liquid light-emitting layer with LOSs sandwiched between two indium tin oxide (ITO) electrodes, was fabricated with photolithography and heterogeneous bonding. LOSs were injected into SU-8-based linear microchannels of 70 mm in length. Three different colors of photoluminescence (PL) emission were observed from flexible linear microchannels. Liner electroluminescence (EL) emission was successfully obtained in the bending state as well as straight state. We expect that the proposed microfluidic OLED ribbons will have high potential for future free-formable wearable devices such as electronic textiles.

Keywords - Liquid organic semiconductors, Liquid OLEDs, Microfluidic OLEDs, Flexible device, Textile

Paper ID : A2L-B-5 (#1298) Withdraw

A2L-C

Graphene and Related Materials

1:25 PM - 3:15 PM, April 18, 2016 Room C (HAGI, 1F)

Masaki Tanemura, Nagoya Institute of Technology (Chair)

Hirokazu Fukidome, Tohoku University (Co-Chair)

Paper ID : A2L-C-1 (#1347)

INVITED TALK

Position-Controlled graphene Synthesis and Development of Biological Sensors and Molecular Devices.....N/A

Kenzo Maehashi

Tokyo University of Agriculture and Technology, Japan

Graphene, a single honeycomb-like sheet of carbon atoms, have been intensively investigated in most recent owing to its extraordinary high mobility even at room temperature. In this study, position-controlled graphene was synthesized using micropatterning on catalytic copper surface for devices. Then, I will introduce highly sensitive electrical detection of biological molecules based on graphene FETs. Finally, I will show fabrication of molecular-based transistors with graphene nanogap electrodes and investigation of the transport characteristics of the molecular device.

Keywords - graphene, sensors, molecular devices

Paper ID : A2L-C-2 (#1232)

Role of Copper Substrate Annealing on Graphene Crystal Synthesis by Atmospheric Pressure Chemical Vapor Deposition.....N/A

Kamal Prasad Sharma, Subash Sharma, Golap Kalita, Masaki Tanemura

Nagoya Institute of Technology, Japan

Metal such as Cu, Ni, Pt surfaces plays catalytic role for the synthesis of graphene. Surface impurities, roughness of such metals plays important role for the synthesis of good quality graphene. In this prospect, we study the effect of annealing process on Cu surface for the synthesis of graphene crystals by atmospheric pressure chemical vapor deposition (AP-CVD). $FeCl_3$ treated Cu foil are pre annealed in Ar to create nascent oxides layers, which is successively reduced on annealing in H_2. By using so treated Cu 450μm graphene crystal synthesized by using solid precursor polystyrene.

Keywords - Graphene, AP-CVD, Crystals, Synthesis

Paper ID : A2L-C-3 (#1153)

Defect Engineering of Graphene for Thermoelectrics.....N/A

Yuki Anno, Yuma Yasui, Kuniharu Takei, Seiji Akita, Takayuki Arie, Masato Takeuchi, Masaya Matsuoka

Osaka Prefecture University, Japan

To apply graphene as thermoelectric devices, low thermal conductivity is required. Because the main heat carrier in graphene is phonon, introducing defects into graphene structure is effective to reduce the thermal conductivity of graphene. Here we show the thermoelectric property of graphene with defects induced by oxygen plasma treatment. Compared to pristine graphene, the peak thermoelectric power of graphene with defects decreases, and its peak position shifts toward the larger absolute back gate voltage. Although defects reduce both the thermoelectric power and electrical conductivity, reduction in the thermal conductivity is greater than that in electrical and thermoelectric properties, leading to higher thermoelectric figure of merit. This means that defects in graphene have a potential to enhance the performance of graphene-based thermoelectric devices.

Keywords - graphene, thermoelectric device, defect

Paper ID : A2L-C-4 (#1104)

3D Graphene-Nanoribbon Ultrafast Electro-Optical Nanosensor.....N/A

Xi Zhang, Yuan Yuan Cao, Dong Feng Diao
Shenzhen University, China

As size decreases, traditional electro-optical sensors based on CCD or CMOS are approaching to their size limit. Graphene is considered as a promising material for the next-generation photodetector, by virtue of its broadband light absorption and high carrier mobility, though the responsivity is limited to tens of mA/W due to the fast recombination of photo-created carriers. External bias manipulates the Fermi-energy of graphene and greatly increased the responsivity, although the response time was as slow as millisecond. There lacks a way to manipulate Fermi-level and to enhance responsivity through altering quantum states of graphene in itself. In this presentation, we introduce our recent progress on 3D graphene-nanoribbon ultrafast electro-optical nanosensor.

Keywords - GNR, photodetector, nanosensor, nems

Paper ID : A2L-C-5 (#1330)

Carbon Nanotubes Based Lubricating Oils for Engines.....42

Nguyen Manh Hong, Bui Hung Thang, Phan Ngoc Hong, Nguyen Tuan Hong, Phan Hong Khoi, Phan Ngoc Minh
Vietnam Academy of Science and Technology, Vietnam

Carbon nanotubes (CNTs) are well-known nanomaterials with many excellent properties such as high hardness, high strength, and excellent thermal conductivity. Owing to their very high thermal conductivity (2000 W/m.K compared to thermal conductivity of Ag 419 W/m.K), CNTs become ones of the most suitable nano additives for fabricating the lubricating oils in order to increase the thermal conductivity of lubricating oils, to enhance the efficiency of heat dissipation for the engine, and to improve the performance efficiency of engine. In this work, we present the obtained results on application of the CNTs in lubricating oils for some engines. The results showed that with the addition of CNTs, the thermal conductivity of lubricating oils increase about 15%, this helps improve the efficiency of heat dissipation for the engine. Experimental results show that when using the lubricating oils containing carbon nanotubes, the temperature of engine dropped about 10°C, fuel saving was upto 15% and longevity of lubricating oil increased upto 20,000 km.

Keywords - carbon nanotube, poly-alpha-olefin (PAO), lubricating oils, engine

Paper ID : A2L-C-6 (#1362)

INVITED TALK

Core-Shell Structures Integrating 2D and 1D Materials for Electron Emission and Clean Energy Applications.....N/A

Daniel Chua
National University of Singapore, Singapore

Carbon materials have attracted much attention due to their unique properties, ranging from low dimensional effects, good structural integrity, high electrical and thermal conductivity, and chemical stability. Increasingly, carbon-based materials have progressed from thin films to the nanoscale dimensions, such as graphite to graphene. There are many potential applications ranging from electronics to conductive coatings to biomedical technology. In this talk, I will focus on the different combinations that is used to integrate 2D and 1D materials successfully, resulting in (for example), graphene directly on carbon nanotubes or 2D-MoS_2 directly on carbon nanospheres. In addition, we also demonstrate depositing 2D graphene on 1D metal cones. Several applications of these nanocomposites will be shown, which include electron emission to supercapacitors and fuel cells.

Keywords - Carbon nanotubes, 2D materials, electron emission, PEM fuel cell

A2L-D

Biomedical micro/nano devices

1:25 PM - 3:00 PM, April 18, 2016 Room D (TOKIWA, B1F)

Tadao Matsunaga, Tohoku University (Chair)

Paper ID : A2L-D-1 (#1296)

INVITED TALK

Emerging Functions of Electrically-Induced Bubble Injector.....N/A

Yoko Yamanishi

Shibaura Institute of Technology / Japan Science and Technology Agency, Japan

We propose a minimally invasive needle-free bubble injector, based on the technology of the micro-electric bubble knife. It applies the mechanism of bubble cavitation, which involves the injection of mono-dispersed micro-bubbles (diameter: less than 10 μm) and the simultaneous transfer of reagents into the target area, by adsorbing the regent or gene in the air-liquid interface of bubbles. We aims to develop a novel needle-free injection system based on its highly targeted microbubble technology. The system has potential advantages over existing needle-free drug delivery techniques as the injector has higher resolution with increased flexibility, and is suitable for a wide range of biological targets with reduced chances of contamination. The injector is originally suitable for cellular level targeting and a wide range of biological targets. The present invention has been tested in an experiment, for perforation of chicken meat. In this experiment, the device has been successfully tested for robustness, minimal invasion, contact force and the ability to inject. The applications based on the electrically-induced bubbles are emerging. For example, the molecule can be concentrated with bubble shrinkage. By using the system, the function can be applied to protein crystallization. Such emerging applications will be also introduced and described.

Keywords - Micro-bubble, Electrically-induced, Injection

Paper ID : A2L-D-2 (#1358)

INVITED TALK

On Chip Preprocessing Technologies for Analysis of Ultra Small Amount of Biopsied Sample.....N/A

Satoshi Konishi

Ritsumeikan University, Japan

Various technologies have been studied for analysis of blood which is the most popular biopsied sample. Progress of preprocessing technology is a key to satisfy the demand for advanced diagnosis using small amount of biopsied sample. This paper presents preprocessing technologies for analysis of blood as well as tissue samples. First, a blood analysis system will be presented, which is composed of a plasma extracting element using a functional filter and, an allocating element using hydrophilic/hydrophobic surface in micro-channels for preprocessing technologies. The developed system allows the sample and answer using only 50ul whole blood sample. Next, we report a direct total mRNA extraction system from biopsied skeletal muscle tissue. Developed system has functions of milling, shredding and isolation for effective mRNA extraction from small amount of tissue.

Keywords - Preprocessing technology, Biopsy, Blood analysis, Skeletal muscle tissue

Paper ID : A2L-D-3 (#1228)

High-Speed and High-Throughput Protein Crystallization and Ablation by Electrically-Induced Bubbles.....N/A

Katsuyuki Hayashi{1}, Takudo Shu{1}, So Takasawa{1}, Yoko Yamanishi{2}

{1}Shibaura Institute of Technology, Japan; {2}Shibaura Institute of Technology / Japan Science and Technology Agency, Japan

We have succeeded in protein crystallization by electrically-driven mono-dispersed micro-bubbles produced by electrically-induced micro-bubble knife. The dispensed high-speed directional micro-bubbles whose air-liquid interface has an induction

force which draw the ambient molecules. The ejected bubbles are contracted and shrunk within several tens second under atmospheric pressure, and hence the partial supersaturation region is appeared at an interface to produce a nucleus of crystal. It was observed that the speed of production of crystals and the number of crystals by electrically-driven mono-dispersed micro-bubble was much higher than control condition for two samples (Lysozyme and Thaumatin) respectively. The current work provides possibility to control the number of crystals and the time required for the protein crystallization by electrically induced bubbles.

Keywords - protein,crystallization,micro-bubble,air-liquid interface

Paper ID : A2L-D-4 (#1270)

Aminosilane Patterning on Substrate Surface by PDMS Soft Stamp for Proteoglycan Molecular Immobilization.....46

Jinseo Hong{2}, Hideharu Sugo{2}, Takashi Mineta{2}, Ikuko Kakizaki{1}
{1}Hirosaki University, Japan; {2}Yamagata University, Japan

This paper presents amino-terminated micro pattern transferring onto a mica substrate using polydimethylsiloxane (PDMS) soft stamp and proteoglycan (PG) molecular immobilization. PDMS bump-arrays with ultra-smooth surface were fabricated utilizing anisotropic etched silicon substrate as a mold. Coating and removal of releasing-agents were investigated to improve detachability of PDMS stamp from silicon substrate. Residual releasing-agents on the surface of the PDMS stamp were completely removed by repeated stamping on dummy mica substrates. After the PDMS stamp was immersed into aminopropyltriethoxysilane (APTES) solution, followed by drying with nitrogen gas blowing, APTES molecules on the PDMS stamp were transferred onto mica substrate. After PG solution was deposited onto the APTES transferred mica substrate, the PG molecules were immobilized both inside and outside the APTES transferred pattern. PG molecules with widely spread glycosaminoglycan (GAG) molecules were successfully immobilized inside the APTES pattern due to amino-termination effect whereas PG molecules with no GAG spreading were also adsorbed outside the pattern.

Keywords - PDMS stamp, patterning, Proteoglycan, APTES, immobilization

Paper ID : A2L-D-5 (#1332)

CMUT Arrays Incorporating Anodically Bondable LTCC for Small Diameter Ultrasonic Endoscope.....50

Fikret Yildiz, Tadao Matsunaga, Yoichi Haga
Tohoku University, Japan

This paper reports fabrication of CMUT (Capacitive Micromachined Ultrasonic Transducer) based forward looking ultrasonic endoscope using custom designed LTCC (Low Temperature Co-fired Ceramic). LTCC wafer is used as bottom substrate (prime wafer) and ring array and linear array are used for CMUT transducers fabrication. Electrical connections between transducer arrays and IC (Integrated Circuits) are achieved by LTCC side via accomplished hexagonal shape dicing of CMUT after fabrication. Design, fabrication process and results are presented. The advantages of CMUT packaging using LTCC side via compared to previously announced CMUT probe packaging such as TSV (Through Silicon Via) scheme are discussed.

Keywords - CMUT,LTCC,anodic bonding, forward looking, side via

A2L-E

Molecular Robotics II (International Symposium on Molecular RoboticsCo-sponsored by KAKENHI Molecular Robotics)

1:25 PM - 3:00 PM, April 18, 2016 Room E (SUEHIRO, B1F)

Hirohide Saito, Kyoto University (Chair)

Paper ID : A2L-E-1 (#1192)

INVITED TALK

DNA Nanostructures and Their Applications.....N/A

Sung Ha Park

Sungkyunkwan University, Korea, South

Nanobiotechnology has evolved into a unique interdisciplinary field involving physics, materials science, chemistry, biology, computer science, and multiple engineering fields. Likewise, DNA nanotechnology is a quickly developing field with essentially no overwhelming technical difficulties inhibiting progress toward designing and fabricating new shapes of DNA nanostructures in all dimensions. In this field, researchers create artificial DNA sequences to self-assemble into target molecular nanostructures. The well understood Watson"Crick base-pairing rules are used to encode assembly instructions directly into the DNA molecules which provide basic building blocks for constructing functionalized nanostructures with two major features: self-assembly and self-alignment. In this talk, we present on self-assembled various DNA nanostructures. 1D and 2D periodically patterned nanostructures utilizing several distinct DNA motifs such as cross tiles, double crossover tiles as well as single-stranded tiles will be discussed with unique design schemes and characteristics. We also discuss new development of DNA fabrication methods such as Angle Control Scheme, Surface Assisted Growth and Dry & Wet Method. At the end of the talk, we address applications of DNA nanotechnology which will show feasibility to construct various physical devices and biological/chemical sensors with DNA nanostructures.

Keywords - DNA Nanotechnology, Self-assembly, Nanoscale, Automation

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Paper ID : A2L-E-2 (#1024)

INVITED TALK

Molecular Computer for Intelligent Molecular Robots.....N/A

Masami Hagiya

University of Tokyo, Japan

In the research project Molecular Robotics, especially in the intelligence team, we have been developing computers of molecular robots. Since they reside inside molecular robots, they are implemented by chemical reactions, i.e., they are molecular computers. The first step in developing molecular computers is to implement combinatorial circuits by chemical reactions to combine various kinds of inputs from sensors and make decisions of molecular robots. The next step is to introduce memory or states because molecular robots should be able to make decisions depending on past situations in order to behave more intelligently. The final step is to realize learning capability and make molecular robots adaptive to the environment. This goal is in parallel with the ultimate goal of the whole research project. In this talk, we report some of the contributions of the research project in the above three steps for developing molecular computers.

Keywords - Molecular robotics, Molecular computing, DNA computing

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Paper ID : A2L-E-3 (#1131)

INVITED TALK

Development of an Amoeba-Type Molecular Robot with Sensors and Intelligence.....N/A

Akihiko Konagaya

Tokyo Institute of Technology, Japan

The amoeba-type molecular robot prototype, which is currently under development, demonstrates a proof-of-concept of a self-propelled robot with molecular sensors, molecular control logic and molecular actuators. In order to achieve the above goal, we employ a giant liposome as a vehicle to distinguish the inside and outside of the molecular robot prototype. The giant liposome which consists of a lipid bilayer provides flexible and functional boundaries like in real amoebas. Molecular sensors play a key role in transmitting signals from the outside to the inside. We use a DNA origami-based molecular receptor with photo-sensitive nucleic acid which releases a signal DNA strand when activated. As for the molecular control logic, we adopt DNA logic gates which receive a signal DNA strand and produce different DNA strands with time delay as output. The molecular actuators consist of microtubules with DNA tags and motor proteins attached on a liposome surface. The DNA tags enable to control the molecular interaction between microtubules by means of DNA logic gates triggered by the output DNA strands.

Keywords - Molecular Robotics, DNA Computing

A3L-A
Micro-fluidics and Nano-fluidics 4

3:20 PM - 4:55 PM, April 18, 2016 Room A (FUJI, 1F)

Takanori Ichiki, University of Tokyo (Chair)

Paper ID : A3L-A-1 (#1183)

INVITED TALK
Implantable Microdevices Based on Semiconductor Technology for Optical Cell Analysis in Vivo.....N/A

Hiroaki Takehara, Toshihiko Noda, Kiyotaka Sasagawa, Takashi Tokuda, Jun Ohta
Nara Institute of Science and Technology, Japan

Light has been used as an energy source for both imaging and therapeutic purposes with the combined use of molecular biological tools, such as photoactivatable molecules and genetically engineered proteins, cells and animals. Despite the appreciable progress in molecular biological tools, several technical issues remain when attempting to deliver light into and detecting optical signals inside biological tissues because of their optical attenuation. Semiconductor technology provides optical devices with both light sources (e.g. light-emitting diodes), and detectors (e.g. photo diodes and complementary metal-oxide semiconductor image sensors). The miniaturization of the optical semiconductor devices to the scale of several millimeters or smaller allows implantation into the body with minimal invasiveness. Here, we present implantable microdevices for both delivery of excitation light and detection of fluorescent signals in biological tissues (in vivo) for cell analysis. The structural device design, fabrication process, and the experimental evaluation of the device performance in fluorescence imaging will be presented.

Keywords - Implantable device, CMOS, Biological sensing, in vivo

Paper ID : A3L-A-2 (#1345)

Flow Injection System for Real-Time Monitoring of Lactic Acid at the Outer Surface of the Skin.....54

Hiroyuki Kudo, Keigo Enomoto, Yota Jingushi
Meiji University, Japan

A flow injection system using electrochemical biosensor for in-time monitoring of lactic acid at the skin's surface was fabricated and tested. The system consists of a 'skin-patch' micro flow-channel and an electrochemical biosensor using a carbon graphite electrode. In contrast to the previously reported sensors for monitoring of sweat lactic acid, a flexible open microchannel for collecting lactic acid at the outer surface of the skin was employed. Lactic acid at the skin's surface is solved into the career flow and it can be measured using the biosensor. Therefore our system measure the amount of lactic acid secretion instead of concentrations of lactic acid in sweat. Owing to this 'skin-patch' flow-channel, transudation of lactic acid was monitored continuously in real-time and the kinetics of the lactic acid was measured with sufficient stability. This system is expected to be used in sports science field such as scientific sports training.

Keywords - biomicrosystem, biosensor, electrochemical, application

Paper ID : A3L-A-3 (#1350)

A Freestanding Microfluidic-Based Thermocouple Biosensor for Enzyme-Catalyzed Reaction Analysis.....58

Zhuqing Wang{1}, Mitsuteru Kimura{1}, Naoki Inomata{2}, Takahito Ono{2}
{1}Tohoku Gakuin University , Japan; {2}Tohoku University, Japan

This research reports a multifunctional thermal biosensor that has thermocouple structures integrated with freestanding microfluidic channels for bio-sensing based on enzyme-catalyzed reactions. The free-standing SU-8 polymer-based microfluidic measurement chamber allows sensitive measurement of small volumes of liquid samples and reduces heat loss to improve the sensitivity. The fabricated thermocouple biosensor shows a sensitivity of approximately 0.5 V/W and a thermal constant time of less than 100ms. The results demonstrate that the thermocouple biosensor was capable of enzyme-catalyzed reaction detection for healthcare application.

Keywords - thermocouple, biosensor, microfluidic channel, thermoal sensor, freestanding fluidic structure

Paper ID : A3L-A-4 (#1049)

Packaging Effect on the Flow Separation of CMOS Thermoresistive Micro Calorimetric Flow Sensors.....62

Wei Xu{1}, Bo Gao{1}, Yi-Kuen Lee{1}, Yi Chiu{2}
{1}Hong Kong University of Science and Technology, Hong Kong; {2}National Chiao Tung University, Taiwan

We systematically study the packaging effect on the performance of CMOS Thermoresistive Micro Calorimetric Flow (TMCF) sensors, including two types of sensor packaging designs: S-type and E-type. For S-type design, the experimental results indicate that not only the sensitivity of TMCF sensors was significantly changed, but also the flow range that compare to the E-type design was dramatically reduced from 0-11m/s to 0-4.5m/s. Comprehensive CFD simulations and concise heater transfer analysis were performed to understand the physics behind these two different designs. A flow regime map (protrusion vs reduced Reynolds number) has been constructed, where the critical boundary curve for the flow separation over the TMCF sensor chips are determined. This flow regime map is a useful guideline for designing a well packaged flow sensor system.

Keywords - calorimetric flow sensor, CMOS MEMS, flow separation, thermoresistive

Paper ID : A3L-A-5 (#1093)

Reconfigurable Liquid-Metal Antenna with Integrated Surface-Tension Actuation.....66

Ryan Gough, Richard Ordonez, Matthew Moorefield, Kevin Cho, Wayne Shiroma, Aaron Ohta
University of Hawaii at Manoa, United States

A new design for a reconfigurable antenna using electrically actuated liquid-metal tuning elements is presented. Liquid-metal slugs vary the electrical length of a resonant slot aperture, changing the operational frequency of the antenna across a 36% tunable bandwidth. The fluidic channels are fabricated with polydimethylsiloxane and are fully sealed with integrated DC actuation pads, providing enhanced versatility over previous designs and enabling future miniaturization.

Keywords - Reconfigurable, Liquid metal, Continuous electrowetting, Slot antenna

A3L-B
NEMS/MEMS 1
3:20 PM - 4:55 PM, April 18, 2016 Room B3 (CHIYO 3, 1F)
Masanori Muroyama, Tohoku University (Chair)
Honglong Chang, Northwestern Plytechnical University (Co-Chair)

Paper ID : A3L-B-1
INVITED TALK
Transparent Triboelectric Nanogenerator.....N/A
Haixia(Alice) Zhang, Jinxin Zhang, Mayue Shi, Xiaoliang Cheng, Yu Song
Peking University, China
This paper reports a novel ultra-thin, stretchable and transparent triboelectric nanogenerator (TENG) based on silver nanowires electrode. To assemble the TENG, we first fabricate the stretchable transparent electrode based on silver nanowires. The relative resistance (R/R0) elongation response of the electrode is greatly linear. The device could not only be mounted on the surface of most objects easily, including our skins, but also work under kinds of different forces, such as compressive force and stretching force. Harvesting mechanical energy based on triboelectrification and electrostatic induction, the maximum output power density of this TENG can achieve to 0.96 W/m^2. The device also could work as a self-powered body motion and touch sensor.

Paper ID : A3L-B-2
INVITED TALK
Leveraging MEMS and flexible sensors to enable self-powered wearable / implanted devices.....N/A
Chengkuo Lee, Hao Wang, Zhuolin Xiang
National University of Singapore, Singapore
Wearable medical devices comprising flexible electronics and sensors have received major research attention recently owing to their considerable practicability for several applications, including health monitoring and disease treatment. By leveraging the MEMS technology and flexible materials fabrication processes, we developed various functional devices aiming at different medical applications. Polymer microneedles in hundreds microns height can be patterned by an innovative drawing lithography technology. They can enable a minimally invasive and self-administrative transdermal drug delivery process. Polydimethylsiloxane (PDMS) based microfluidic dispensing networks, check valves, micro pump and SU-8 microneedles can be integrated on a patch device to achieve finger driven on-chip drug loading and delivery functions. A triboelectric electrical generator is also integrated on the microneedle skin patch for a self-powered liquid volume monitoring function. With polymer MEMS technology, we also developed a novel flexible neural ribbon electrode with self-adaptive feature for nerves with various diameters. This device first time realizes implantation on the rat sciatic nerve branches. The recording capability of the neural ribbon on small nerves with different diameter was demonstrated by signal acquisitions from sciatic nerve, peroneal nerve, tibial nerve and sural nerve, respectively. With these features, self-powered wearable and implanted devices will become indispensable in the future healthcare applications.

Paper ID : A3L-B-3 (#1048)
Parametrically Tunable Coupling Factor for the Weakly Coupled Resonators.....70
Hemin Zhang, Weizheng Yuan, Jiming Zhong, Honglong Chang
Northwestern Polytechnical University, China
In this paper, we presented the electrostatic tuning functions of the coupling factor for the weakly coupled resonators (WCRs) for the first time. A WCRs system with two mechanical coupled double-ended-tuning-fork (DETF) resonators is designed, fabricated and tested to verify the tuning theory. In consistency with the theoretical expectations, the experimental results show that the coupling factor is in a quadratic function with the bias voltage, and the coupling factor exponentially decays with the

relevant geometry parameters. A large tunable range of the coupling factor with the minimum value of ~0.000917 and the maximum value of ~0.00196 is obtained by tuning the bias voltage applied on the WCRs. It lays the foundation for controlling the sensitivity and resolution of the WCRs based sensors.

Keywords - weakly coupled resonators, coupling factor, electrostatic negative stiffness, quadratic tuning

Paper ID : A3L-B-4 (#1319)

Highly Transmissive Plasmonic Color Filter by Free-Standing Metal-Insulator Metal Subwavelength Grating.....N/A

Masato Mitsudome{2}, Hiroaki Honma{2}, Makoto Ishida{2}, Kazuaki Sawada{2}, Kazuhiro Takahashi{2}, Shintaro Itoh{1}
{1}Nagoya university, Japan; {2}Toyohashi University of Technology, Japan

We developed a free-standing metal-insulator-metal (MIM) subwavelength grating by nanoimprint and lift-off techniques. Residual-free and high aspect ratio of 6:1 nanoimprint technique produce Al/SiO_2/Al multi-layered subwavelength gratings. With the sacrificial etching process, MIM subwavelength grating was successfully released. The wavelength of the transmission peak was found to be 670 nm whose transmittance was over 90%.

Keywords - surface plasmon, MIM, plasmonic color filter, nanoimprint

Paper ID : A3L-B-5 (#1227)

Verification of Charging Mechanism and Thermal Stability of Potassium Ion Electret.....N/A

Kazunori Ishibashi{1}, Noriko Shimomura{2}, Daiki Nakasone{2}, Yasuhide Fujita{2}, Tatsuhiko Sugiyama{2}, Gen Hashiguchi{2}
{1}Saginomiya Seisakusho, Inc., Japan; {2}Shizuoka University, Japan

We will report verification and validity of the charging mechanism of the potassium ion electret. In addition, since the implementation of the high temperature acceleration test, we will also report the results of the thermal stability of the electret. Use limit time in the -1dB is more than 100 years, it is found to have sufficient ability.

Keywords - electret, MEMS, potassium ion, SiO-

A3L-C

Conference paper award session

3:35 PM - 4:35 PM, April 18, 2016 Room C (HAGI, 1F)
Yoshiaki Kanamori, Tohoku University (Chair)
Joerg Froemel, Fraunhofer ENAS (Co-chair)

Paper ID : A3L-C-1 (#1079)

Nanopores Created Using an Internal Shadowmask Process.....74

Lennart de Vreede, Erwin Berenschot, Niels Tas, Wesley van Den Beld, Josh Loessberg-Zahl, Albert van Den Berg, Jan Eijkel
Universiteit Twente, Netherlands

We report on the manufacturing of nanopore through-holes by heating gold nanoparticles on a silicon oxide (SiO_2) sheet, suspended in a silicon-rich nitride membrane (SiRN). Membrane patterning is performed using self-alignment by an internal shadow mask based process. A benefit of this approach is the ease at which downscaling of the lithographic features can be achieved. With a single alignment, a shadow mask is etched and metal is deposited. The nanopore through hole is then created after heating. In this paper this scalable technique is applied to create non-buckled membranes by combining the compressive and tensile stress components in a SiO_2/SiRN bilayer. Theory on the bilayer stresses is given in order to characterize the buckling. The nanopore through holes are characterized using ionic current measurements and electron microscopy techniques.

Keywords - gold, nanopore, dewetting, SiRN, SiO_2

Paper ID : A3L-C-2 (#1272)

Single-Cell Death Recognition Using Optically-Induced Electrokinetics Biomems Chip.....N/A

Yuliang Zhao{1}, Guanglie Zhang{3}, Gwo-Bin Lee{2}, Wen Jung Li{1}
{1}City University of Hong Kong, Hong Kong; {2}National Tsing Hua University, Taiwan; {3}Shenzhen Academy of Robotics, China

We will report at the conference a single-cell multimodal parameters measurement and big data analysis method for recognizing the living states of 10,000 cells per hour. First, an optically-induced electrokinetics (OEK) chip is used to produce dielectrophoresis force to lift cells up vertically in a fluidic medium and then allowed them to fall freely to the bottom of the chip while their motions are tracked using micro-vision methods. During this sedimentation process in the OEK chip, we could measure each cell's 26 kinds of morphology characteristics, 28 kinds of cellular movement characteristics, and 30 kinds of single-cell mass and density related biophysical signatures. This microimage-based method operates in a label-free and automated process and do not affect the living states of the cells. Consequently, we have discovered that the dead L1210 cells (mouse lymphocytic leukemia cells) are significantly heavier than live L1210 cells. Moreover, the correct rate of single-cell living states recognition is near 90% on average based on these multimodal parameters using single hidden layer Back Propagation (BP) neural network recognition algorithm.

Keywords - Single-Cell, Death Recognition, Multimodal Detection, Data Mining, BioMEMS Chip

Paper ID : A3L-C-3 (#1106)

Analysis and Design of a Single-Molecule DNA Nanodevice for Thermal Band-Pass Filters.....79

John Rose{1}, Ken Komiya{2}
{1}Ritsumeikan Asia Pacific University, Japan; {2}Tokyo Institute of Technology, Japan

We previously proposed, modeled, and experimentally validated a temperature-sensitive DNA nanodevice as a potential platform for implementing a tunable thermal band-pass filter. Due to its peculiar hill-shaped efficiency profile, which differs markedly from the sigmoidal melting curves observed for isolated DNA folding, this device could be used to control other molecular machines, and thus represents a promising biotechnological advance. Preliminary simulations established the basic feasibility of tuning the device for filter operation. However, the dependencies of the peak temperature, width, and peak value of the efficiency curve on the stabilities of the device components, which is essential information for guiding design, remained unclear. In this work, an exact closed-form expression for the peak temperature is derived and validated, and the behavior of this expression is examined and used to produce an algorithm for designing device implementations with target operating characteristics. This algorithm is then used to produce a targeted filter design, with simulations of device behavior. Finally, application of the system model to folding error estimation is discussed.

Keywords - DNA nanodevice, single-molecule, DNA folding, thermal filter, statistical thermodynamics

Paper ID : A3L-C-4 (#1178)

The "Climate" System: Nano-Reactor for in-situ Analysis of Solid-Gas Interactions Inside the TEM.....85

Hector Hugo Pérez-Garza, Diederik Morsink, Jeff Xu, Mariya Sholkina, Yevheniy Pivak, Merijn Pen, Sander van Weperen, Qiang Xu
DENSsolutions, Netherlands

We present the development of a Nano-Reactor for in-situ studies of solid-gas interactions inside the Transmission Electron Microscope (TEM). This MEMS-based device acts as a multi-functional sample carrier and micro-sized laboratory for heating and gas experiments. Each Nano-Reactor consists of two Nano-Chips, which are sandwiched together to form a minimized chemical reaction chamber. The bottom Nano-Chip contains a four-point-probe micro-heater, which controls and introduces the heating environment (up to 1300°C) around the sample. The top cover Nano-Chip encases the gas while isolating it from the external environment, creating the closed Nano-Reactor. Samples are prepared directly onto the electron transparent windows

which allow for the electron beam to pass through for in situ imaging. The thin windows, made of Si_3N_4, can sustain pressures up to 1 bar and high temperatures while ensuring low background atomic resolution imaging.

Keywords - Nano-Reactor, in-situ, TEM, solid-gas interactions

A3L-D

Nano scale fabrication

3:20 PM - 4:45 PM, April 18, 2016 Room D (TOKIWA, B1F)

Koji Sugano, Kobe University (Chair)

Paper ID : A3L-D-1 (#1359)

INVITED TALK

Evelopment of Next Generation Block Copolymer Lithography Materials.....N/A

Teruaki Hayakawa

Tokyo Institute of Technology / Japan Science and Technology Agency, Japan

Fabrication of line and space patterns with sub-10 nm width is an essential part of the development of next generation microelectronic devices. Block copolymer (BCP) lithography is regarded as a strong candidate for sub-10 nm width line patterning. For achieving the high-resolution patterning, development of desired BCP materials and its perpendicular orientation control of microphase-separated lamellar structures are particularly important. Here we show the development of a new series of silicon-containing BCPs and their orientation control and long range ordering of microphase-separated nanostructures. Highlight is that rapid and mild thermal annealing at 110-130 °C for only one minute is achieved the formation of perpendicular oriented lamellar structures with sub-10 nm features in the designed new BCPs.

Keywords - Block Copolymer, Self-assembly, Lithography, sub-10 nm, Perpendicular Orientation, Microphase-separated Nanostructure

Paper ID : A3L-D-2 (#1167)

Thermal Properties of Suspended Silicon Nanowires with Sub-25 nm Half-Pitch Fabricated by EUV Interference Lithography Using Raman Spectroscopy.....N/A

Daniel Fan{2}, Hans Sigg{2}, Yasin Ekinci{2}, Ralph Spolenak{1}

{1}Eidgenössische Technische Hochschule Zürich, Switzerland; {2}Paul Scherrer Institut, Switzerland

Silicon nanowires are an outstanding material for NEMS devices, suitable for energy harvesting, photovoltaics, bio-sensing, etc. Here we fabricate sub-25 nm half-pitch suspended silicon nanowires with linewidths down to 6 nm using EUV interference lithography combined with controlled oxidation and etching. Further, the nanowires are large area (μm2) and very well ordered, allowing access to a number of characterization techniques. We use Raman spectroscopy to probe the thermal properties of the nanowires, which have important consequences for a variety of NEMS devices. Local temperature was measured via the Stokes / anti-Stokes intensities, while laser power dependency of the Raman peak position and width indicated the optical phonon anharmonic constants, crucial for characterizing thermal conductivity in silicon.

Keywords - Extreme ultraviolet (EUV), silicon nanowires, interference lithography, Raman spectroscopy, thermal conductivity

Paper ID : A3L-D-3 (#1251)

Nanopore Formation in Electrolyte Solution to SiO_2 Membrane Using Pulse-Voltage Injection.....N/A

Kentaro Kawai{2}, Yuichi Shibuno{1}, Takumi Hayashi{1}, Zhipeng Ma{1}, Naoki Yamashita{1}, Seongsu Park{1}, Kosuke Tanabe{1}, Kenta Arima{2}, Mizuho Morita{2}, Osamu Tabata{1}

{1}Kyoto University, Japan; {2}Osaka University, Japan

Nanopore fabrication method to insulator mem-brane is presented. Applying voltage to SiO_2 membrane in electrolyte solution to both sides of membrane results nanopore formation. Nanopore formation to SiO_2 membrane is caused by dielectric

breakdown in several-nanometer thickness of a thin insulator membrane, which contains defects. Free-standing SiO_2 membrane was fabricated on Silicon substrate by anisotropic etching of alkaline solution. Diameter of 2nm nanopore was fabricated by pulse-voltage injection in KCl solution.

Keywords - Nanopore, Nanopore sequensing, DNA sequensing, Single-molecle sensing

Paper ID : A3L-D-4 (#1279)

Large-Area Controllable Silver Nanocrystal Patterns for Surface-Enhanced Raman Spectroscopy.....N/A

Wei-Wei Xu{2}, Masanobu Haraguchi{2}, Toshihiro Okamoto{2}, Bin-Bin Xu{1}
{1}University of New South Wales, Australia; {2}University of Tokushima, Japan

A new and facile method of fabrication large-area silver nanocrystal arrays was introduced for high sensitive and uniform surface-enhanced Raman spectroscopy (SERS) detection. Nanostructured silicon substrate was processed by laser interference and used to be a template for silver nanocrystals growing by galvanic battery reaction method. Large-area of violent chemical reaction would be tailored into nano-area array, which makes the silver nanocrystals growing slower, uniform and size controllable. The optimized silver arrays exhibit great potential for ultrasensitive molecular sensing in terms of high SERS enhancement ability, good stability, and reproducibility.

Keywords - SERS laser interference silver nanocrystals galvanic battery reaction

Paper ID : A3L-D-5 (#1014)

Fabrication and Characterization of Fine Pitch TSV Integration with Self-Aligned Backside Insulation Layer Opening.....91

Yong Guan{1}, Qinghua Zeng{1}, Yuan Bian{1}, Xiao Zhong{1}, Jing Chen{1}, Yunhui Zhu{1}, Shenglin Ma{2}, Yufeng Jin{1}
{1}Peking University, China; {2}Xiamen University, China

High density and fine pitch through silicon via integration is becoming a leading trend in current and future three dimensional integration technology. This paper proposes an fine pitch through silicon via fabrication approach for three-dimensional integration. The features are that the self-aligned backside insulation layer opening is realized by leveraging deep reactive ion etching and chemical-mechanical polished process instead of lithographic process which can ensure the integrity of the through silicon via side wall on the insulation layer. Low frequency and high frequency electrical performance are characterized to demonstrate the quality of through silicon via interconnects and isolation. All test results support the good quality of this fine pitch through silicon via integration approach.

Keywords - fine pitch TSV, self alignment, backside insulation layer opening, electrical performance

A3L-E

Molecular Robotics III (International Symposium on Molecular RoboticsCo-sponsored by KAKENHI Molecular Robotics)

3:20 PM - 4:45 PM, April 18, 2016 Room E (SUEHIRO, B1F)

Masami Hagiya, University of Tokyo (Chair)

Paper ID : A3L-E-1 (#1116)

INVITED TALK

Development of Slime-Type Molecular Robot with Sensor and Intelligence.....N/A

Satoshi Murata
Tohoku University, Japan

In the evolution scenario of molecular robots [1], the second generation molecular robots is called slime mold robots. In the development of slime-type molecular robot, we aim at increasing the scale of their sizes by means of functionalized polymer gels that work as both reaction field for information processing and actuator/sensor. In order to organize the reaction field, we

propose a concept of “gelullar automata” and their implementations using DNA-based gels [2]. The gellular automata are a kind of cellular automaton in which cells of automata are composed of gel compartment filled with a solution with designed DNA logic reactions (e.g. toehold-mediated strand displacement). The products of the reaction (output molecule of the DNA logic) diffuse into surrounding cells to initiate further cascade of logic operation. We show elementary spatio-temporal computation such as a simple pattern generation on the gellular automata. We also discuss general strategies to implement the gellular automata to slime mold robots.

Keywords - slime-type molecular robot

Paper ID : A3L-E-2 (#1290)

Size Controllable Homomultimer Made of Single DNA Origami Monomer.....N/A

Yuma Endo, Keita Abe, Takeo Uchida, Shosei Ichiseki, Satoru Akita, Shiyun Liu, Sho Aradachi, Masataka Saito, Akihiko Fukuchi, Taiyo Kikkawa, Theo Dammaretz, Ibuki Kawamata, Shin-Ichiro Nomura, Satoshi Murata
Tohoku University, Japan

In nature, various biological functions are realized by multimeric proteins. Those proteins have intrinsic curvature and the number of monomers in a multimer is determined by their circular assembly. In linear assembly, however, it is difficult to control the number of proteins without additional capping mechanisms. Here, we propose a novel mechanism to control such linear assembly by employing a mechanism inspired by vernier. We designed a nanoscale DNA origami monomer that can count the number of stacking using the vernier mechanism. It consists of a hollow cylinder and a twisted shaft, where the shaft can rotate inside the cylinder. Since the shaft is slightly twisted, there is a phase shift between stacking angles on its ends. As the monomers stack, the phase shift accumulates on the shaft. The monomers are capable of stacking until the accumulated twist reaches the limit defined on the cylinder. The elaborate design enables us to make size-controllable DNA origami complexes, which provide a novel possibility for structural nanotechnology.

Keywords - Molecular robotics, DNA origami, Twisted shaft, Vernier mechanism, Linear homomultimer, AFM observation

Paper ID : A3L-E-3 (#1089)

DNA A/D Converter by Team Kyutech in BIOMOD2015.....N/A

Ryudai Seguchi, Youhei Umeda, Kento Ogata, Tomotaka Omagari, Katsuhiro Nishijima, Hiroki Miyahara, Yasuaki Mizuta, Daiki Sato, Keigo Fujimoto, Ippei Asada, Kentaro Kurihara, Ryosuke Suzukawa, Takashi Nakakuki
Kyushu Institute of Technology, Japan

We propose an analog-to-digital (A/D) converter realized by DNA reactions by combining threshold gate, and some DNA logic gates built on the basis of the seesaw gate model. Our A/D converter reads the concentration of an input DNA and converts it into binary number depending on the DNA concentration. We also design the DNA sequences required for the one- and three-bit DNA A/D converters and conduct an in-silico experiment to verify their validity.

Keywords - Molecular Robotics, A/D converter, DNA, strand displacement reaction

Paper ID : A3L-E-4 (#1155)

Using a Master and Slave Approach for GPGPU Computing to Achieve Optimal Scaling in a 3D Real-Time Simulation.....95

Greg Gutmann{2}, Daisuke Inoue{1}, Akira Kakugo{1}, Akihiko Konagaya{2}
{1}Hokkaido University, Japan; {2}Tokyo Institute of Technology, Japan

With the ever increasing computational demand of scientific research and data analysis, there has been a migration towards GPU computing. GPU are now the primary source of compute power in most top supercomputers. But in order to make use of the power programs must utilize more than a single GPU. Within this paper we will explain various approaches we have taken to utilize multiple GPU, and attempt to reach close to perfect scaling on a multi-step simulation. The result of this is having developed our simulation to be computed on a master and slave setup of GPU. Our simulation mentioned is being developed for the purpose of simulating microtubule dynamics on a gliding assay.

Keywords - GPGPU, Multi-GPU, Microtubule Gliding Assay, 3D Simulation, Real-time

Paper ID : A3L-E-5 (#1166)

Investigation of the Microtubule Dynamics with Probabilistic Data Association Filter.....101

Bulibuli Mahemuti{2}, Daisuke Inoue{1}, Akira Kakugo{1}, Akihiko Konagaya{2}
{1}Hokkaido University, Japan; {2}Tokyo Institute of Technology, Japan

Understanding microtubule dynamics has important implications for establishing nanometer level machines. Object tracking is one of the important issues necessary to elucidate the dynamics of microtubule from video data. In microtubule gliding assays, object tracking becomes non-trivial due to the occurrences of compound objects and high density objects. In this work, we investigate microtubule dynamics focusing on its morphological information, and we developed easy and useful workflow with compound segmentation technique and probabilistic data association filter. Using this workflow, multi-crossing microtubules can be decomposed, and be tracked correctly.

Keywords - Microtubule gliding assay, Bio-image informatics, Multiple-object tracking, Probabilistic data association filter

B0L-A
Plenary Talk 2
8:35 AM - 9:25 AM, April 19, 2016 Room A (FUJI, 1F)
Shuji Tanaka, Tohoku University (Chair)
Takahito Ono, Tohoku University (Co- Chair)

Paper ID : B0L-A-1

Inertial-Navigation-on-a-Chip: Self-Calibrating Bulk Acoustic Wave Gyroscopes.....N/A

Farrokh Ayazi
Ken Byers Professor of Microsystems
Director, Center for MEMS and Microsystems Technologies
Georgia Institute of Technology

Navigation using integrated inertial sensors (gyroscopes and accelerometers) is one of the grand challenges that MEMS researchers have tried to address. A number of challenges have hindered the development of integrated inertial measurement units that can be used for navigation in applications such as autonomous cars, drones, and personal navigation, with the most important one being the “drift” of the gyroscope. High-frequency bulk acoustic wave (BAW) gyroscopes are a new class of MEMS inertial sensors that enable the level of accuracy and robustness against environmental signal that are needed for inertial navigation. In this talk, integration of high frequency tri-axial bulk acoustic gyroscopes and accelerometers on a single-chip using a high aspect-ratio nano-gap process will be presented. Novel self-calibration architectures are being developed to eliminate the drift in gyroscopes, which will be discussed along with wafer level packaging of the IMU and integration with electronics.

B1L-A
Tactile devices & systems
9:45 AM – 10:55 AM, April 19, 2016 Room A (FUJI, 1F)
Toshiyuki Tsuchiya, Kyoto University (Chair)
Hiroshi Miyaguchi, Tohoku University (Co-Chair)

Paper ID : B1L-A-1 (#1255)

INVITED TALK
Microsystem Integration Technologies for the Next Generation Tactile Systems.....N/A

Masanori Muroyama
Tohoku University, Japan

In this talk, a next generation tactile system by using microsystem integration technologies will be introduced. This presentation reveals that (1) MEMS sensor and CMOS-LSI integration technologies in addition to the human inspired responses of threshold based activation and adaptation like a human tactile receptor and (2) a multi-type sensor platform CMOS-LSI, in which capacitive and resistive sensor readout circuits, a temperature sensor, signal processing and data transmission circuits are included. This platform is specially designed for a sensor network system of social robot applications. This system adopts an event-driven tactile sensor network system for implementing numerous tactile sensors on the whole surface of robots. As a communication method, an effective asynchronous bus based serial communication with our proposed packet format is used. With the platform CMOS-LSI, sensor type, sensitivity, sampling rate and other parameters can be configured according to system requirements flexibly.

Keywords - Tactile Sensors, CMOS-MEMS integration, Sensor network platform

Paper ID : B1L-A-2 (#1259)

A Multiple Sensor Platform with Dedicated CMOS-LSIs for Robot Applications.....245

Chenzhong Shao{2}, Takahiro Nakayama{4}, Yoshiyuki Hata{3}, Travis Bartley{2}, Yutaka Nonomura{1}, Shuji Tanaka{2}, Masanori Muroyama{2}
{1}Meijo University, Japan; {2}Tohoku University, Japan; {3}Toyota Central R&D labs., Inc., Japan; {4}Toyota Motor Corporation, Japan

In recent years, there has been an increasing interest in robots' tactile sense, which enables safer, more reliable and accurate human-robot communication for the future society. So far, we have developed a capacitive type tactile sensor network system for implementing a large number of sensors with MEMS-CMOS integration technologies. Considering practical use for the robot, multiple kind sensors in addition to numerous sensor distributions are necessary in terms of accurate object recognition and wide coverage of sensor requirements such as high-sensitivity, large dynamic range, high-reliability and low-cost. Thus, we proposed a sensor platform with dedicated CMOS-LSIs, which can utilize three types of sensors: on-chip temperature, off-chip capacitive and resistive tactile sensors. The CMOS-LSI is well designed for integration with MEMS. This paper describes the first implementation results of the multiple kind sensors with the CMOS-LSIs. We successfully constructed the multi sensor system, which has the temperature sensor, capacitive and resistive type force sensors.

Keywords - Robot Application, CMOS-LSI, sensor platform, multiple sensors, tactile sensor network system

Paper ID : B1L-A-3 (#1261)

A Shape Memory Alloy Thick Film Actuator Array for Narrow Pitched Planar Tactile Display Device.....251

Hiroshi Yanatori{2}, Takashi Mineta{2}, Shuichi Takeuchi{1}, Konomu Abe{1}
{1}Tokai Rika Co., Ltd., Japan; {2}Yamagata University, Japan

This paper presents a MEMS type shape memory alloy (SMA) thick film actuator array for a tactile display which renders texture to human finger skin by mechanical stimulations. We propose a planar tactile display combined with SMA film actuator array (5 x 5 array, 1 mm pitch). The deflectable planar spring-shape SMA actuator with micro-heater circuits was batch- fabricated from a 10-μm thick SMA film. Fabrication process techniques were newly developed, and then the SMA actuator array device was realized. The generated force and displacement of the SMA actuator at high and room temperatures were 40 mN and 25 mN, respectively (initial deflection: 100 μm). With a bias spring combination, the reversible force generation and displacement can be estimated as 5 mN and 20 μm which are large enough for mechanical stimulation to human skin.

Keywords - SMA thick film, Tactile display, Microactuator array, Planer structure

Paper ID : B1L-A-4 (#1028)

Dual Resonant Structure for Energy Harvesting from Random Vibration Sources.....255

Shanshan Li, Zhuoteng Peng, Ai Zhang, Dan Luo, Fei Wang
Southern University of Science and Technology, China

This paper reports a new design with dual resonant structure which is more efficient than single resonant devices for random vibration energy harvesting. The dual resonant structure consists of two spring-mass subsystems, which exhibits strong coupling when the two masses collide with each other. Experiments with piezoelectric elements show that the energy harvesting device with dual resonant structure can generate higher power output than the sum of the two separate devices from random vibration sources at low frequency.

Keywords - Energy harvesting, broad bandwidth, random vibration sources, piezoelectric

B1L-B

Advanced micro/nano fabrication technologies 1

9:45 AM – 10:55 AM, April 19, 2016 Room B3 (CHIYO 3, 1F)

Shinya Kumagai, Toyota Technological Institute (Chair)

Paper ID : B1L-B-1 (#1204)

INVITED TALK

Glass Reflow Process and its Applications.....260

Nguyen Van Toan{2}, Suguru Sangu{1}, Takahito Ono{2}
{1}Ricoh Company, Ltd., Japan; {2}Tohoku University, Japan

This paper reports on a glass reflow process and its applications. In this process, glass compounded silicon structures is achieved with the help of vacuum cavities under applying the high temperature. Three applications employing the glass reflow process, through-wafer interconnects, thermal isolation, and optical window, have been proposed and investigated.

Keywords - Glass reflow process, through-wafer interconnects, thermal isolation, Glass capillary optical window

Paper ID : B1L-B-2 (#1210) Withdraw

Paper ID : B1L-B-3 (#1336)

Performance Investigation of Ductile-Regime Single Point Diamond Microcutting of Optical Glass.....N/A

Yuan-Liu Chen, Keisuke Tohyama, Yuki Shimizu, So Ito, Wei Gao
Tohoku University, Japan

This paper an experimental investigation of ductile regime single point microocutting of optical glass by using a diamond tool with a negative rake angle. A high-sensitivity force sensor was integrated with the tool for detection of the tool-sample contact and enableing the force-controlled microcutting. The force-controlled microcutting and displacement-controlled microcutting were compared. The effects of the machining parameters including diamond tool rake angles, feed rate, cutting fluids on the surface quality of the machined brittle materials including glass and silicon were comprehensively investigated.

Keywords - Ductile cutting, Single point diamond microcutting, Optical glass, Force-controlled cutting

Paper ID : B1L-B-4 (#1095)

Transparent Metal Mesh Based on Roll to Sheet UV Imprinting Using a PDMS Soft Mold.....265

Cheng-Hsin Chuang, Bo-Hsiang Chang, Jian-Ming Chen
Southern Taiwan University of Science and Technology, Taiwan

Transparent conductive electrodes (TCE) possessing a combination of high optical transmission and good electrical conductivity find applications in numerous optoelectronic devices. In this study, we propose the low cost fabrication of a fine metal mesh structure on a glass substrate as a promising and feasible approach for fulfilling large size TCE requirements. We have utilized a Roll-to-Sheet (R2S) ultraviolet (UV) imprinting technique to transfer micro trench structures on glass using a PDMS soft mold. The conductive silver paste is filled into the micro trench structures by controlling the processing parameters which include pressure, scraping angle and speed. The metal mesh based glass shows a transmission in excess of 90% and haze of only 1.92%, respectively, while the electrical resistance is as low as 6.12Ω/. Furthermore, we believe that this method can be utilized as an economically viable alternative to ITO in TCE applications.

Keywords - Metal mesh, TCE, Roll-to-sheet UV imprinting

B1L-C
Nanoscale Robotics, Assembly, and Automation
9:45 AM - 11:00 AM, April 19, 2016 Room C (HAGI, 1F)
Satoshi Murata, Tohoku University (Chair)

Paper ID : B1L-C-1 (#1126)

Cubical Photonic Structures by Means of Ion Beam Assisted Robotic Assembly.....270

Waldemar Klauser, Sören Zimmermann, Malte Bartenwerfer, Sergej Fatikow
Carl von Ossietzky Universität Oldenburg, Germany

Fabrication of tailored photonic structures with sufficient precision is a major topic in photonics since decades. However, until now, the assembly of photonic structures in order to control light propagation in all three spatial dimensions remains challenging. This paper presents a reliable approach for fabricating three-dimensional structures consisting of individually stacked colloidal particles. The combination of a robotic dual-probe setup inside a scanning electron microscope and the purposeful use of ion beam based etching and deposition techniques allows to fabricate on-demand three-dimensional photonic structures with cubic geometry. The advantages and limits of this technique are highlighted with respect to further application scenarios.

Keywords - nanorobotic assembly, photonic structures, colloidal particles, ion beam processing

Paper ID : B1L-C-2 (#1132)

Self-Deformable Micro/Nanomotors with Organic-Inorganic Hybrid Structures.....275

Yoshitaka Yoshizumi, Masatoshi Yokokawa, Hiroaki Suzuki
University of Tsukuba, Japan

This paper proposes a method to create a self-deformable structure consisting of tethered multiple micromotors. Although micromotors reported up to now features only translational motion and transport of cargos, the tethered structure can do “close-to-open” changes by combining hard inorganic segments and soft organic tethers. The structure can be a basis to realize sophisticated micro/nanomachines that may be used for applications such as micro-scaled surgery and drug delivery.

Keywords - Micro/nanomotor, Self-electroosmosis, Polyelectrolyte, Layer-by-layer self-assembly, Deformable structure

Paper ID : B1L-C-3 (#1058)

Parallel Actuation and Independent Addressing of Many Bubble Microrobots.....279

M Arifur Rahman, Julian Cheng, Aaron Ohta
University of Hawaii at Manoa, United States

Twenty-four bubble microrobots were optothermally actuated in parallel. The bubble microrobots were independently controlled by a computer-generated holographic (CGH) control system. This work demonstrates the actuation of many microrobots that are capable of performing an assigned task such as micro-assembly with increased throughput. To the best knowledge of the authors, these are the most microrobots independently actuated in parallel to date.

Keywords - Microrobot, Microassembly, Opto-thermal actuation

Paper ID : B1L-C-4 (#1018)

High Power Three Degrees of Freedom Mini Actuator Using a Parallel Mechanism.....283

Shraga Shoval
University of South Wales, Australia

In this paper we present a conceptual design for a powerful hydraulic micro actuator that provides three degrees of freedom motion. The actuator consists of three hydraulic pumps and three semi-flexible spherical pressure vessels. The spheres are configured like a 3D Stewart platform mechanism, where the tip of the actuator is attached to the upper plate of the mechanism. By controlling the internal pressure, the spheres’ radii are adjusted. The actuator provides micro positioning mechanism using

standard hydraulic pumps, and therefore the mechanism is a cost effective, accurate and powerful positioning solution for a 3D micro actuator.

Keywords - micro actuator, hydraulic pumps, Stwart Platfrom

Paper ID : B1L-C-5 (#1300)

Development of Micro-Scale Tensile Fatigue Test System.....289

Naoki Hayakawa{2}, Kensuke Tsuchiya{2}, Toshifumi Kakiuchi{1}
{1}Gifu University, Japan; {2}University of Tokyo, Japan

We developed a micro-scale tensile fatigue test system, which can test specimens fabricated from bulk materials. In this system, a probe is attached to a micro-manipulator and the micro-manipulator enables accurate initial positioning and applying tensile stress. In this paper, we present the system and the result of tensile tests and tensile fatigue tests on the specimens which are made of single crystal grains of magnesium alloy, AZ31. The tensile tests suggests that the system can apply accurate tensile stress to the micro-scale specimens and the tensile strength of micro-scale structures is little stronger than that of bulk materials. And the tensile fatigue tests indicates that the system can apply cyclic tensile stress.

Keywords - micro-scale, tensile fatigue test, magnesium, AZ31, crystal orientation, micro-manipulator

B1L-D
Micro-fluidics and Nano-fluidics 2
9:45 AM - 11:10 AM, April 19, 2016 Room D (TOKIWA, B1F)
Takanori Ichiki, University of Tokyo (Chair)

Paper ID : B1L-D-1 (#1088)

INVITED TALK
Direct Electron Transfer Reaction of Cytochrome C Immobilized on ITO Electrode Modified with Phosphonic Acid Self-Assembled Monolayer Film.....N/A

Naoki Matsuda, Hirotaka Okabe
National Institute of Advanced Industrial Science and Technology, Japan

Slab optical waveguide (SOWG) spectroscopy by which in situ observation of UV-vis. absorption spectra from adsorbed molecules on solid/liquid interface. We have reported direct electron transfer (DET) reaction of cytochrome c immobilized on ITO electrode could be observed by SOWG spectral change due to electrode potential scan, and that cytochrome c immobilized on ITO electrodes kept DET activity without addition of any promoters or mediators. Tone of the technical issues of cytochrome c DET functionality forward electronics devices is desorption of them from electrode surfaces. Thus 10-carboxydecylphosphonic acid self-assembled monolayer (SAM) film was formed on ITO electrode, and this SAM film showed sufficient effect to keep both DET functionality and immobilization of cytochrome c. In this presentation, we will report the effect of ITO electrode surface modification with phosphonic acid SAM film including 10-carboxydecylphosphonic acid (10-CDPA) on DET of cytochrome c.

Keywords - slab optical waveguide spectroscopy, direct electron transfer reaction, cytochrome c, ITO, phosphonic acid, self-assembled monolayer film

Paper ID : B1L-D-2 (#1321)

Droplets Oscillation and Mixing Between Plates with Electrowetting.....N/A

Hanlai Chen{1}, Shih-Kang Fan{1}, Jing Ding{2}, Wen-Quan Tao{2}
{1}National Taiwan University, Taiwan; {2}Xi'an Jiaotong University, China

Abstract - This paper reports droplet oscillation with electrowetting between two parallel plates. Different from droplet oscillation previously reported on an open surface, here we investigate the oscillation when applying voltage between plates, which can be further implemented as a mixer in a digital microfluidic device. The control parameters, including the droplet geometry and

the amplitude and frequency of the driving signal were examined. The droplet internal flow was visualized by the suspended particles, showing that the oscillation offered internal convection and enhanced mixing in the droplet.
Keywords - microdroplet, oscillation, electrowetting

Paper ID : B1L-D-3 (#1323)

Heterogeneous Hydrogels with Patterned Illumination on a Digital Microfluidic Device.....N/A

Yi-Ling Chen, Shih-Kang Fan
National Taiwan University, Taiwan

For the first time, we construct hydrogels with (1) arbitrary shapes programmable through a DMD (digital microfluidic device) and (2) adjustable heterogeneous materials assembled in liquid phase through manipulated prepolymer droplets on an electromicrofluidic device. A cross-shaped PEGDA (poly (ethylene glycol) diacrylate) containing varied fluorescent dyes and particles was demonstrated. Different hydrogels containing varied biomolecules and cells can be manipulated for creating three dimensional (3D) in vivo-like microenviroments in the application of tissue engineering or in vitro physiological studies.
Keywords - hydrogel, pattern, DMF

Paper ID : B1L-D-4 (#1307)

A Multibody Brownian Dynamics for Modeling Size-Separation of dsDNA Fragment and DNA Origami Tiles in Anisotropic Nanosieving Array.....N/A

Seongsu Park{1}, Zhipeng Ma{1}, Naoki Yamashita{1}, Kentaro Kawai{2}, Do-Nyun Kim{3}, Yoshikazu Hirai{1}, Toshiyuki Tsuchiya{1}, Osamu Tabata{1}
{1}Kyoto University, Japan; {2}Osaka University, Japan; {3}Seoul National University, Korea, South

In this paper, we present a novel simulation scheme for on-chip size-separation of DNA origami nanostructures. We combined Brownian dynamics for arbitrarily shaped rigid body with multibody dynamics, in order to achieve more flexible modeling of DNA origami nanostructures, which feature great diversity in its structure and internal degree of freedom. Additionally, by considering steric-hindrance and external electric field, we can simulate on-chip size-separation of various DNA nanostructures. In particular, we were able to reproduce the experimental result of DNA separation in 2D Anisotropic Nanofilter Array (ANA) in silico and investigate possible separation resolution for cross-linked DNA origami tiles under varing conditions.
Keywords - DNA origami, Brownian Dynamics, Size separation, Anisotropic Nanofilter Array

Paper ID : B1L-D-5 (#1234)

Development of a Self-Priming Microfluidic Device for Generating Nanoliter Droplet Array.....N/A

Cheng-Je Lee, Yu-Hsiang Hsu
National Taiwan University, Taiwan

In this paper, we present a newly developed self-priming method for generating multiple nanoliter droplet array. This method is based on the combination of an ultra-thin polypropylene microfluidic device and a thin polypropylene vacuum pouch. The vacuum pouch serves as an on-chip vacuum source for loading target solutions into the microfluidic channels and also generating nanolitter droplet array. The overall thickness of the developed microfluidic device can be less than 0.4 mm. Further, since the manufacturing process is compatible with standard vacuum packing process, this self-priming microfluidic device can potentially be mass produced. The design, fabrication, and experimental results will be detailed in this paper, and the potential application to digital polymerase chain reaction will also be discussed.
Keywords - digital PCR, plastic microfluidic device, self-priming system, Lab-on-a-Chip

B1L-E
Metamaterial Special Session 1
(Cooperation with IEEJ(code:E) Investigating R&D Committee on Applications of Metamaterials and Plasmonics to Optical and Electronic Devices)
9:45 AM - 11:00 AM, April 19, 2016 Room E (SUEHIRO, B1F)
Koji Sugano, Kobe University (Chair)
Tatsunosuke Matsui, Mie University (Co-Chair)

Paper ID : B1L-E-1 (#1181)

INVITED TALK

Plasmon-Based Physics and Chemistry Using Nano-Engineered Gold Nanoparticles.....N/A

Kosei Ueno
Hokkaido University, Japan

The enhancement of electromagnetic field using localized surface plasmon resonance (LSPR) opens a promising field of optical and sensor applications using Raman scattering, second harmonic generation, and near-field optical microscopy. We fabricated arrays of gold nanostructures on solid substrates by electron beam lithography and lift-off techniques with very high accuracy, uniformity, and reproducibility. The spectral properties and electromagnetic field enhancement were explored by two photon excited photoluminescence of gold and photopolymerization through the use of the gold nanostructures having the nano-gap, which was controlled with a single nanometer precision. Optically distinguishable sub-nanometer changes in the length of rectangular gold nanoparticles prove that the structures were precisely fabricated with high resolution and that the ensemble of such nanoparticles had no considerable inhomogeneous broadening of its extinction spectrum. As one of the chemical applications of LSPR, homogeneous nano-patterning on photoresist films using the directional scattering components of light coupled with the radiation mode of plasmon resonance (higher-order plasmon resonance) as an exposure source will be also presented.

Keywords - Plasmom, Nano-fabrication, Chemical reaction, Optical antenna

Paper ID : B1L-E-2 (#1316)

INVITED TALK

Regulated Nanofabrication by Utilizing Grafted Polymer Layers Towards Metamaterials.....N/A

Shoichi Kubo
National Institute for Materials Science, Japan

Grafted polymer layers can mediate two different materials and enable the configuration of functional nanostructures. Here, two fabrication approaches by utilizing grafted polymer layers will be presented from the viewpoints of top-down and bottom-up technologies toward metamaterials. Nanoimprint lithography has attracted much attention as a promising next-generation lithography technique. Fine patterns are replicated from a mold to thin resin films which function as resist layers. Photochemically grafted polymer layer on a substrate stabilized resin thin films and improved the lateral resolution. The fabrication of a double-gap Au split-resonator array with a feature size of sub-100 nm was demonstrated over a 5-mm square area towards visible frequency metamaterials. Grafted polymer layers also assist the uniaxial alignment of inorganic nanorods owing to the organization of nematic liquid crystalline (LC) materials. Nematic LC polymers grafted from the nanorod surfaces with regulated density caused cooperative molecular interactions between nematic LC polymers and small nematic LC molecules and induced the hierarchical orientation propagated from an alignment layer to small nematic LC molecules, nematic LC polymers, and polymer-grafted nanorods. This methodology is widely applicable nanorods with various materials including semiconductors and noble metals leading to top-down plasmonic metamaterials.

Keywords - metamaterials, nanoimprint lithography, graft layer, liquid crystals

Paper ID : B1L-E-3 (#1335)

INVITED TALK

Metallic Split-Ring Resonator Metamaterial Fabricated by Nanosphere Lithography.....N/A

Toshihiro Okamoto, Kota Tanikawa, Masanobu Haraguchi
University of Tokushima, Japan

The split-ring resonator (SRR) was first reported Pendry et al. in 1999 and the structure has attracted much attention due to the “negative refractive index” property, shown theoretically by Veselago. SRRs cause magnetic resonance near the LC resonance frequency and change the permeability of the SRR metamaterial. The size of the SRR must be reduced to around 100 nm for operation in the visible / near-infrared region; however, it is technically difficult to make an SRR this small with high accuracy. In addition, it was a virtually impossible task the three-dimensional (3D) and high density configuration of SRRs. Recently, we succeeded in fabricating SRRs of high density and the 2D configuration of the large area (over 10×10 mm^2) using a nanosphere lithography (NSL) technique. In addition, the SRR film in which SRRs were embedded by the polystyrene was fabricated, and they were stacked. We will introduce the fabrication method and the optical property of our SRR optical metamaterial.

Keywords - Split-ring resonator, Metamaterial, Nanosphere lithography

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B2L-A

Piezoelectric MEMS

11:20 AM - 12:20 PM, April 19, 2016 Room A (FUJI, 1F)
Toshiyuki Tsuchiya, Kyoto University (Chair)
Masanori Muroyama. Tohoku University (Co-Chair)

Paper ID : B2L-A-1 (#1133)

Highly Sensitive Piezoelectric Micromachined Ultrasonic Transducer (pMUT) Operated in Air.....294

Tao Wang{2}, Takeshi Kobayashi{1}, Bin Yang{3}, Hao Wang{2}, Chengkuo Lee{2}
{1}National Institute of Advanced Industrial Science and Technology, Japan; {2}National University of Singapore, Singapore; {3}Shanghai Jiaotong University, China

Piezoelectric micromachined ultrasonic transducer (pMUT) gains increasing interests from researchers. It overcomes the inherent shortcomings of conventional bulk ultrasonic transducers such as acoustic impedance mismatching, and also does not require the extremely large input voltage as capacitive micromachined ultrasonic transducer (cMUT). The lead zirconate titanate (PZT) based pMUT has the best performance. Leveraging on our newly developed pulse poling process, the PZT thin film is of high piezoelectric constant (d31=105pm/V) and low dielectric loss (~0.06). Benefited from such high performance PZT thin film and optimized design, the fabricated pMUT (500×300μm) achieves a displacement sensitivity of 807nm/V at its resonant frequency (482kHz) without DC offset.The in-air transmitting performance is evaluated as well. A single pMUT element is able to generate 63.7dB sound pressure level (SPL) at 10 mm in air with 2V input. The low input voltage provides low power consumption, and also prevents the unwanted PZT repolarization. The proposed highly sensitive pMUT shows its promise for integration with portable electronics.

Keywords - MEMS, ultrasonic transducer, piezoelectric, pMUT, gesture recognition

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Paper ID : B2L-A-2 (#1346)

Vibration Modes in Impulse Response of Piezoelectric Diaphragms for Ultrasonic Microsensors.....300

Kaoru Yamashita, Taiki Nishiumi, Hikaru Tanaka, Minoru Noda
Kyoto Institute of Technology, Japan

Vibration modes of piezoelectric diaphragms for ultrasonic mi-crosensors have been investigated from the viewpoint of vibrations at higher frequencies than the fundamental one in impulse responses of the diaphragms in variations of their shapes;

square or circular and flat or buckled. The diaphragms have shown the higher vibration modes due to the broad spectrum of the ultra-sound pulse. However, some of the modes have even higher fre-quency beyond the ultrasound pulse's. The beyond-higher modes have been found to be generated by the diaphragm itself during the damping oscillation, and the higher modes are the least in the circular-buckled diaphragms, which were not clarified from piezoelectric responses but have been revealed in this work by transient laser Doppler vibrometry.

Keywords - diaphragm, vibration mode, polarization, ultrasonic sensor

Paper ID : B2L-A-3 (#1258)

Tunable Nonlinear Resonance in a Piezoelectric MEMS Diaphragm with Floating Bottom Electrode.....N/A

Zhiyuan Shen{3}, Ajay Giri Prakash Kottapalli{3}, Mohsen Asadnia{4}, Jianmin Miao{2}, Michael Triantafyllou{1}
{1}Massachusetts Institute of Technology, United States; {2}Nanyang Technological University, Singapore;
{3}Singapore-MIT Alliance for Research and Technology, Singapore; {4}University of Western Australia, Australia

The nonlinear resonance behavior in a piezoelectric MEMS diaphragm has been studied. The device is based on sol-gel deposition of piezoelectric thin film (lead zirconate titanate, PZT) on SOI wafers and bulk microfabrication process. The diaphragm bears one unbiased bottom electrode (floating electrode) and two biased top electrodes. The floating electrode plays the function of inducing an electric field that is in the diaphragm thickness direction and uniformly distributed in the top electrodes-covered area. The residue stress accumulated during film deposition has induced hardening nonlinear resonance. DC biasing and mass loading can tune the resonance frequency and the amplitude of the nonlinear resonance.

Keywords - piezoelectric, MEMS, nonlinearity, diaphragm, spring hardening, tuning

Paper ID : B2L-A-4 (#1268)

Investigation of Curie Temperature of $Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$ Epitaxial Thin Film on Si Fabricated by Sputter Deposotion with Fast Cooling Process.....N/A

Yukihiro Hasegawa{1}, Shinya Yoshida{1}, Kiyotaka Wasa{2}, Shuji Tanaka{1}
{1}Tohoku University, Japan; {2}Yokohama-City University, Japan

In this study, we have evaluated Curie temperature of $Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$ (PMN-PT) epitaxial thin film on Si fabricated by sputter deposition with fast cooling process. 0.67PMN-0.33PT thin films were epitaxially grown on Si substrates covered with buffer layers. The deposition experiment indicated that the fast cooling process can reproducibly provide a PMN-PT epitaxial thin film with pure perovskite phase. Then, the Curie temperature of 1-um-thick thin film was evaluated. As a result, the temperature measured approximately 200°C which is 50~60°C higher than that of the bulk crystal. This abnormal gain of the Curie temperature has the potency to create new piezoelectric thin films satisfying both large piezoelectricity and high Curie temperature.

Keywords - piezoelectric MEMS, relaxer-based piezoelectric material, $Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$ (PMN-PT)

B2L-B

Advanced micro/nano fabrication technologies 2

11:20 AM - 12:30 PM, April 19, 2016 Room B3 (CHIYO 3, 1F)

Reo Kometani, University of Tokyo (Chair)

Paper ID : B2L-B-1 (#1339)

INVITED TALK

3D Micro Printer to Expand its Applications Into Variety of Research Fields.....N/A

Youhei Kamata, Andreas Frölich
Nanoscribe GmbH, Germany

We, Nanoscribe GmbH, have offered various and many research institutions our multi-photon absorption polymerization based 3D laser direct writing system worldwide as an alternative tool which can provide a new degree of freedom, true 3D, into their

microfabrication tasks since we spinned off from Karlsruhe Institute of Technology as a company in 2007. We initially developed the technology for the research field of nanophotonics but nowadays applications of our technology extensively cover new cutting-edge fields such as mechanical metamaterials, biomimetics, Cell biology and things as well as 3D photonics. Particularly our latest Galvo technology siginificantly speeding up our systems by almost 100 times our traditional systems in their writing speed has opened up our system's new aspect of abilities as 3D printer for microscale which can make even macro 3D structures since we presented the new development in January, 2013. We would present that variety of applications users of our system has worked on as well as our technologies including Galvo technology and hope you could find clues for breakthroughs in your studies even a bid from our presentation this time.

Keywords - Multi-photon absorption polymerization, 3D laser direct writing, microfabrication, 3D printer

Paper ID : B2L-B-2 (#1239)

Characterization of Solid UV Curable 3D Printer Resins for Biological Applications.....305

Shilpa Sivashankar, Sumeyra Agambayev, Ulrich Buttner, Khaled Nabil Salama
King Abdullah University of Science and Technology, Saudi Arabia

In this paper, we report a simple method to evaluate biocompatibility of solid UV cross-linked resin as a material for microfluidic devices that can be used for biological applications. We evaluated the biocompatibility of the material in two different ways (1) determining if the UV cured resin inhibits the polymerase chain reaction (PCR) and (2) observing agglutination complex formed on the surface of the UV cured resin when anti-CRP antibodies and C-reactive protein (CRP) proteins were allowed to agglutinate. Six different types of 3D printer resins were compared to test the biocompatibility. The study showed that only few among them could be used for fabrication of micro channels and that had least effect on biological molecules that could be used for PCR and protein interactions.

Keywords - Biomaterials, microfluidic systems, 3D printer resins

Paper ID : B2L-B-3 (#1098)

Spray Coating of Polymer Electret with Nano Particles for Stable Surface Charge.....310

Yixin Xu, Anxin Luo, Ai Zhang, Yulong Zhang, Kai Wang, Fei Wang
Southern University of Science and Technology, China

In this paper, we have proposed a spray coating method for electret deposition. With this method, the thickness of electret can be well controlled and the surface potential of the charged electret can be improved comparing to the traditional spin coated polymer electrets. Furthermore, we have added some polystyrene nano particles into the electret, which can improve the surface charge stability of the electret at high temperature or in high humidity environment. We have also confirmed that our new electret could be used in the energy harvesting devices and may have promising applications on other MEMS devices.

Keywords - Electret, Spray Coating, Energy Harvesting, Charge Stability, MEMS

Paper ID : B2L-B-4 (#1026)

Vapor-Condensation-Assisted Reverse Display for Anti-Counterfeiting Applications.....316

Xuemin Du, Juan Wang, Huanqing Cui, Tianhong Tang, Tian-Zhun Wu
Shenzhen Institutes of Advanced Technology / Chinese Academy of Sciences , China

We propose a simple yet effective method for the display based on vapor condensation on the hydrophilic-hydrophobic patterned surfaces. Supersaturated water vapor will first form nanometer-sized water droplet on the condensation nuclei on the patterned surfaces, and then the water droplet will grow bigger and therefore scatter more light to make the outline of the patterns visible for naked eyes. This vapor-condensation-assisted display is applicable to a variety of substrates from Si wafers to mirrors. By employing condensed water droplets as the image pixels, it does not induce any impurities to the specimens. Moreover, this low-cost and efficient technique can be potentially used in various fields.

Keywords - display, invisible images, vapor condensation, anti-counterfeiting

B2L-C
Nano-biology and cell
11:20 AM - 12:30 PM, April 19, 2016 Room C (HAGI, 1F)
Shoichi Toyabe, Tohoku University (Chair)

Paper ID : B2L-C-1 (#1214)

INVITED TALK
Shape Regulation of Microparticles Mimicking Cells.....N/A
Miho Yanagisawa
Tokyo University of Agriculture and Technology, Japan
Micro-sized gels and droplets (microparticles) are main components of biomedical, cosmetic, and foods materials. Non-spherical microparticles can provide various functions such as drug delivery of microcapsules and filtration of porous materials. However, conventional methods are generally difficult to adapt for biopolymers. To solve this problem, we focused on cellular structure. Cells regulate their structures of biopolymers in a spontaneous manner. We mimic such structure by using model cells: microdroplets of a biopolymer blend of aqueous two phase systems [1]. Temperature shift to trigger phase separation and/or gelation produces various patterns of the biopolymers. In the case of sol-gel coexisting phase, microcapsules and hemisphere microgels are appeared as stable states according to complete and partial wetting of the polymer. In addition, gelation during phase separation brings various patterns in meta-stable states. Furthermore, the wetting of the gelation polymer is found to vary local elasticity of the microgels. These findings demonstrate a way to regulate shape and structure of biopolymer microdroplets using the interplay among phase transitions of confined biopolymers [2].
[1] M. Yanagisawa, et al., Int. Rev. Cell Mol. Biol., 307:175, 2014. [2] M. Yanagisawa, et al., Proc. Natl. Acad. Sci. USA, 111:15894, 2014.
Keywords - Microgel, Emulsion, Wetting, Phase separation

Paper ID : B2L-C-2 (#1083)

Activating Biological Reactions with a Low-Temperature Atmospheric Pressure Plasma.....N/A
Yuto Nakayama{3}, Shinya Kumagai{3}, Hiroshi Hashizume{2}, Takayuki Ohta{1}, Masafumi Ito{1}, Masaru Hori{2}, Minoru Sasaki{3}
{1}Meijo University, Japan; {2}Nagoya University, Japan; {3}Toyota Technological Institute, Japan
We have fabricated a micro system for activating microorganisms or cells. The micro system used a low-temperature atmospheric pressure plasma as stimuli for activating the biological reactions of a microorganism or a cell. The micro system performs three tasks; capturing a biological sample, irradiating a part of the sample with the plasma, and cooling the sample. We have analyzed how the plasma-irradiation affected the microorganisms or cells. Here, pollen of Lathyrus odoratus was irradiated with the plasma. Under specific conditions, the germination was promoted.
Keywords - atmosheric pressure plasma, biological reaction, microorganism, cell

Paper ID : B2L-C-3 (#1019)

Paper-Based Verticle Flow Platform for White Blood Cell Count by Cell Trapping.....N/A
Yi Zhang, Jianhao Bai, Hong Wu, Jackie Ying
Agency for Science, Technology and Research, Singapore
White blood cell count is an important indicator of individual's health condition. Monitoring white blood cell count can potentially help individuals to take preventive measures and improve healthcare outcomes. Currently, white blood cell count is primarily conducted in centralized laboratories, and it requires specialized equipment and dedicated personnel. So far there has been no rapid test that allows white blood cell count in low-resource settings. In this abstract, we have demonstrated a vertical flow platform that quantifies white blood cells by trapping them in the paper. Using this platform, we were able to quantify white blood cells in 15 μL of blood, and visually differentiate the abnormal count of white blood cells from the normal count. The proposed

platform enabled rapid white blood cell count in low resource settings. Its low cost and instrument-free operations would be attractive for point-of-care applications.

Keywords - Flow-through, gold nanoparticle, paper microfluidics, vertical flow, white blood cell count

Paper ID : B2L-C-4 (#1333) Withdraw

B2L-D
Molecular Sensors 1
11:20 AM - 12:20 PM, April 19, 2016 Room D (TOKIWA, B1F)
Liang He, Wuhan University of Technology (Chair)

Paper ID : B2L-D-1 (#1209)

Combined Chemotaxis-infotaxis Strategy for Odor Source Localization Using Mobile Sensor Nodes.....N/A

Muis Muhtadi, Takamichi Nakamoto
Tokyo Institute of Technology, Japan

We present combined strategy of chemotaxis and infotaxis for odor source localization and concentration distribution mapping using three moveable sensor nodes. Two types of node are defined for this three-nodes formation, two supporting nodes with their task to collect odor information in a rectangular area and a leading node with its task to approach to estimated odor source location. These supporting nodes move using chemotaxis strategy to collect odor information. This collected information is used to construct odor distribution map locally on the rectangular area that cover all the collecting nodes. This map is used as an infotaxic reference navigating the leading node toward the odor source location. This odor map is updated periodically and moved along with the supporting nodes toward the odor source location.

Keywords - Odor Source Localization, Chemotaxis, Infotaxis, Odor Distribution Map

Paper ID : B2L-D-2 (#1092)

A Nano-Gap Biosensor Using Nano-Patterned Conductive Molecule for cTnT Detection.....320

Hsiao-Ting Hsueh, Po-Han Chen, Chih-Ting Lin
National Taiwan University, Taiwan

It is desirable to develop one novel biosensor by using simple nanostructure. In this paper, we propose a novel biosensor using simple nano-gap electrodes accompanying conductive linkers for bio-detection. Nano-gap electrode concentrates current near the surface. The conductive linkers (CB2C and PABA), which were immobilized on the gap surface, formed a conductive layer between two electrodes. The conductance increment of CB2C and PABA linker was about 56% and 396% respectively. This conductance improvement provides nano-gap electrodes ability for cTnT detection, also, the dynamic detection range of CB2C and PABA is from 1ng/ml to 100ng/ml and from 10pg/ml to 100ng/ml respectively. The results also proved that the thickness of conductive layer is a critical factor in conductance and detection limit.

Keywords - Nano-gap, Coplanar Electrodes, Conductive Linker, Biosensor, cTnT

Paper ID : B2L-D-3 (#1096)

Real-Time Monitoring via Patch-Type Piezoelectric Force Sensors for Internet of Thing in Logistics.....325

Cheng-Hsin Chuang, Wan-Ching Weng, Wan-Jung Chang, Da-Huei Lee
Southern Taiwan University of Science and Technology, Taiwan

We propose the use of simple and low cost piezoelectric based patch type sensors for internet of thing (IoT) that ensure safety of the package while also detecting damage during shipment. A tear off sensor located at the top of the package can identify if the package has been opened while an impact sensor located at the bottom can monitor the damage suffered. The sensors are connected to a low power microcontroller (MCU) unit to analyze the data and a radio frequency (RF) module to transfer the data wirelessly. It would be viable to have an on-vehicle telematics device for collecting and analyzing data from multiple packages wirelessly so that it can be uploaded to the cloud, thus allowing for real time monitoring during transport. This logistics management model would aid in improving the quality of services provided by the logistics company while also earning consumer credibility. Thus, we believe that these patch-type force sensors can be realistically implemented IoT in logistics in the near future.

Keywords - Piezoelectric patch type sensor, Logistics, Real time monitoring

Paper ID : B2L-D-4 (#1292) Withdraw

B2L-E

Metamaterial Special Session 2

(Cooperation with IEEJ(code:E) Investigating R&D Committee on Applications of Metamaterials and Plasmonics to Optical and Electronic Devices)

11:10 AM - 12:25 PM, April 19, 2016 Room E (SUEHIRO, B1F)

Kosei Ueno, Hokkaido University (Chair)

Paper ID : B2L-E-1 (#1326)

INVITED TALK

Observation of Fano Resonance in Optical Metamaterials.....N/A

Yoshiaki Kanamori
Tohoku University, Japan

Using metamaterials, innovative optical characteristics breaking through traditional optics have been highly expected, in the optical region. However, fabrication of metamaterials operated in the optical region is difficult, because their unit sizes have sub-micron order. To obtain fine optical responses, high precision fabrication of metamaterial structures is highly required. We have developed high precision fabrication of ultra-small metamaterial structures. Then, we fabricated two metamaterials, that is, electromagnetically induced transparency (EIT) metamaterials and asymmetric double bars (ADB) metamaterials with simple structures and sharp Fano resonance. Metamaterials with Fano resonance have high Q-factors because radiation loss is suppressed efficiently. For the EIT metamaterials, at wavelengths of 647 nm (Red), 514 nm (Green), and 462 nm (Blue), transmittance peaks indicating EIT-like characteristics were clearly observed. For the ADB metamaterials, measured optical spectra clearly showed sharp Fano resonances due to weak asymmetry of ADB structures. For the two metamaterials, numerical calculations based on rigorous coupled-wave analysis agreed well with experimental spectra.

Keywords - Metamaterials, Nano photonics

Paper ID : B2L-E-2 (#1176)

INVITED TALK

Plasmonic Nanostructure Based on Self-Assembled Gold Nanoparticles for Highly Sensitive Surface-Enhanced Raman Spectroscopy.....N/A

Koji Sugano
Kobe University, Japan

This talk will reports a fabrication of plasmonic nanostructures using template-assisted self-assembly of gold nanoparticles. This technique enables us to fabricate designed gold nanostructures according to template nanopatterns. The application of the fabricated structures to ultrasensitive surface-enhanced Raman spectroscopy (SERS) will be reported. For example, the gold nanoparticle dimer, which has been reported as the highest Raman enhancing structure, was directionally arrayed on a substrate for the first time. The highest enhancement can be achieved when a particle connection direction of a dimer is matched to polarization direction of incident light. Therefore the huge enhancement can be achieved at all dimers. Optimizing the dimer arrangement, high sensitive and rapid bio/chemical molecule detection was achieved. In addition, the latest achievement about single molecule SERS detection will be reported.

Keywords - Plasmonics, self-assembly, gold nanoparticle, surface enhanced Raman spectroscopy

Paper ID : B2L-E-3 (#1129)

INVITED TALK

Active Terahertz Metamaterials Utilizing Organic/ Inorganic Semiconductor Hybrid System.....N/A

Tatsunosuke Matsui{1}, Keisuke Takano{2}, Makoto Nakajima{2}
{1}Mie University, Japan; {2}Osaka University, Japan

The researches on terahertz (THz) science and technologies have made significant progresses in recent years. In order to develop active THz devices such as filters, modulators, and imagers, numerous attempts have been made to modulate THz radiation by external stimuli. To utilize metamaterials is also actively studied approach. Semiconductor substrates such as Si, GaAs, InSb have been widely used since enough amounts of free carriers for THz modulation can easily be obtained by light irradiation or thermal heating. Recently, Yoo et al. reported on the efficient photo-induced modulation of the THz transmission through a Si substrate deposited with a thin layer of copper phthalocyanine (CuPc). We have found that the thickness of CuPc film is the crucial parameter in obtaining higher THz transmission modulation. We have fabricated array of split-ring resonators (SRRs) on CuPc/Si utilizing super-fine inkjet printer and demonstrated that CuPc/Si system could be used to efficiently control THz resonant responses of SRR array metamaterials. We have also investigated other solution-processed organic semiconductors. Our findings may open the way for developing various types of novel metamaterials, which is currently under active study.

Keywords - Metamaterials, Terahertz, π-conjugated materials

B4L-A
NEMS/MEMS 2
3:10 PM - 4:20 PM, April 19, 2016 Room A (FUJI, 1F)
Masanori Muroyama, Tohoku University (Chair)
Honglong Chang, Northwestern Plytechnical University (Co-Chair)

Paper ID : B4L-A-1 (#1244)

INVITED TALK
Mems Based Test-Stand Device for "Nano" Characterization.....N/A

Toshiyuki Tsuchiya
Kyoto University, Japan

In this talk, micro electro mechanical system (MEMS) devices which enable us to characterize properties of nano materials as well as phenomenon in nanoscale physics are introduced and their future possibilities are going to be discussed. MEMS technology is now being applied as a tool for interfacing nanotechnology. Therefore, MEMS based test-stand devices will provide us a tool to explore “nano” because of their mass production capabilities, good fabrication accuracies, and well developed integrations to controlling/readout circuits, which is realized through development of microsensors and microactuators. For example, a capacitive accelerometer detects the displacement of smaller than one nano-meter and a force of nano- or pico-newton range. It also has an ability to generate such a small displacement and force. For nanomaterial characterization, we have developed silicon-on-insulator tensile-testing devices for tensile-testing a fullerene polymer nanowire, a single-walled carbon nanotube and a silicon nanowire. Our technique is specialized in specimen integration process, in which we considered the capability of the batch-integration of the nanomaterials to MEMS for future mass production. Another application is a tool for investigating novel physical properties in nanoscale. We are now developing the device to fabricate a large-area and uniform nanogap to measure the transportation in it.

Keywords - MEMS Test-Stand Device, Nanomaterials, Nanophysics

Paper ID : B4L-A-2 (#1070)

High Temperature Fiber Sensor with High Sensitivity Based on Mach-Zehnder Interferometer.....N/A

Na Zhao{1}, Qijing Lin{1}, Zhuangde Jiang{1}, Haiwei Fu{2}, Bian Tian{1}, Zhongkai Zhang{1}, Zirong Wu{1}, Qiuyue Yu{1}, Chen Zheng{1}, Feng Han{1}, Lei Li{1}
{1}Xi'an Jiaotong University, China; {2}Xi'an Shiyou University, China

A simple and compact thin-core fiber (TCF) Mach-Zehnder interferometer (MZI) is proposed for temperature measurement. The sensor head is composed by a short section of TCF embedded between two single-mode fibers (SMFs). The MZI works on the basis of interference between the core mode and cladding modes in TCF. The transmission spectrum of the sensor is analyzed by the fast Fourier Transform (FFT), which indicates that the interference mainly occurs between LP01 and LP010 modes. A high temperature sensitivity of 0.088 nm/°C is achieved from 30 to 400 °C, and the linearity is 99.8%. The configuration features the advantages of easy fabrication, a compact size, high sensitivity, wide sensing range and high mechanical strength, making it a good candidate for high temperature measurement of hot gas, oil and gas well logging and other areas.

Keywords - temperature measurement,fiber sensor,Mach-Zehnder interferometer, thin-core fiber.

Paper ID : B4L-A-3 (#1219)

A1 Mode Lamb Wave on Thin $LiTaO_3$ for High Frequency Acoustic Devices.....473

Najoua Assila, Michio Kadota, Yuji Ohashi, Shuji Tanaka
Tohoku University, Japan

The Lamb wave and horizontal shear wave propagation in $LiTaO_3$ thin plate is investigated as a function of Euler angles. Both velocity and electromechanical coupling factor largely depend on the plate’s thickness. Around (0°,30°,0°), $LiTaO_3$ thin plate has a high velocity and a suitable coupling factor for a high frequency filter. Authors fabricated A1 mode Lamb wave resonators in (0°,39°,0°) $LiTaO_3$’s thin plate. Lamb wave velocities and leaky Lamb wave velocities were measured by network analyzer

and ultrasonic microscopy. Measured velocities correspond to the ones calculated by FEM. Velocities higher than 20,000 m/s were obtained. It is shown that A1 mode Lamb wave close to (0°,30°,0°) $LiTaO_3$ thin plate is suitable for high frequency devices.
Keywords - Lamb waves, $LiTaO_3$, High velocity, Resonance, Ultrasonic Microscopy

Paper ID : B4L-A-4 (#1220)

GaN Mechanical Resonators on Silicon Substrate Fabricated by Two-Step Polymer Bonding.....N/A

Takashi Sasaki, Yuta Hayakawa, Kazuhiro Hane
Tohoku University, Japan

A polymer bonding method of GaN crystal layer on silicon substrate is proposed for the integration of GaN micro electromechanical devices on silicon substrate. The bonding method consists of two steps polymer processes to prevent from breaking the bonded GaN layer by air bubbles. The bonded GaN layer is used for fabricating GaN micro mechanical resonators on silicon substrate by etching the polymers as scrilyficial layer. A few types of micro resonators are designed and fabricated from the GaN layer. A cantilever resonator is activated by optical means and the basic characteristics are examined.
Keywords - polymer bonding, mechanical resonator, optical waveguide, photothermal effect

B4L-B
Fabrication of organic materials
3:10 PM - 4:35 PM, April 19, 2016 Room B3 (CHIYO 3, 1F)
Shinya Yoshida, Tohoku University (Chair)
Takaaki Suzuki, Gunma University (Co-Chair)

Paper ID : B4L-B-1 (#1354)

INVITED TALK
Flexible and Printed Organic TFT Devices and Their Applications.....N/A

Shizuo Tokito
Yamagata University, Japan

In this paper, printable materials, printed organic TFT (OTFT) devices and their application to TFT arrays and integrated circuits will be briefly presented. Printed OTFT arrays were successfully fabricated by using newly developed organic semiconductor (OSC) material on plastic film substrates. By optimizing the crystal growth semiconducting layer crystal growth,for the new OSC excellent p-type electrical performance with a high mobility of 1.9 cm^2/Vs and high current on/off current ratios over 10^7 were achieved. ExcellentExceptional uniformities ity of the device performance characteristics within the panel wereas also observed within in the array. We successfully fabricated attempted to fabricate pseudo-CMOS inverters using the p-type OTFTs, as well asand NAND logic gates that circuits based on the pseudo-CMOS were also successfully fabricated and exhibited ideal characteristics. Very high gains over 250 were obtained in the printed pseudo-CMOS inverters. Real CMOS inverter using both p-type and n-type OSC materials are significantly important for the integrated circuit fabrication. We have proposed stacked TFT structure for the CMOS inverter and fabricated using our n-type OSC material (TU-3) and a commonly used p-type OSC material. Good switching characteristics were observed and a high gain over 20 was obtained at a low operating voltage. Based on this CMOS inverter a three"stage ring oscillator and D-flip flop circuits were also demonstrated on an ultra-thin plastic film substrate.
Keywords - Printing, Flexible Electronics, Printed Electronics, Organic Electronics, Ornanic TFT, Integarted Circuits, Biosensors

Paper ID : B4L-B-2 (#1254)

Aligned P(VDF-TrFE) Piezoelectric Nanofiber Bundles as a Scaffold for Cell Alignments.....N/A

Chen-Hao Chan{1}, William C. Tang{2}, Yu-Hsiang Hsu{1}
{1}National Taiwan University, Taiwan; {2}University of California, United States

Electrospinning method has been well studied and applied in a broad range of engineering and manufacturing, including the biomedical fields for wound healing, drug delivery,and scaffolds for tissue engineering applications. However, it hasbeen a challenge to control the orientation of electrospun nanofibers with the existing practices of electrospinning. Recent studies have showed that using an inclined gap to serve as the collector, the majority of nanofibers could be aligned in one direction, although the distance between nanofibers were still random. In this paper, we report our research on using a serrated collector with an inclined gap to align electrospun piezoelectric nanofiber bundles, which could potentially be used for tissue engineering applications. By controlling the tip angle, separation distances, and pitch on the two opposing serrated edges, multiple aligned piezoelectric nanofiber bundles could be generated bridging across every two opposing teeth. The potentials in using this novel approach for controlling cell alignment will be reported.

Keywords - electrospinning, alinged piezoelectric nanofibers, cell alignment

Paper ID : B4L-B-3 (#1266)

Non-UV Layer-by-Layer Printing of Hydrogel Microstructures via Optically Controlled Electropolymerization (OEP).....N/A

Pan Li{2}, Na Liu{2}, Haibo Yu{2}, Feifei Wang{2}, Lianqing Liu{2}, Wen Jung Li{1}
{1}City University of Hong Kong, Hong Kong; {2}Shenyang Institute of Automation, China

Hydrogel micro/nanofabrication technologies play a pivotal role for fabrication of microdevice, microrobot, and scaffold in bioengineering. Here, a concept of optically controlled electropolymerization is reported, which is based on optical image pattern-defined localized polymerization in a photo-sensitive microfluidic chip. The electropolymerization process and kinetics were studied and results will be presented at the conference. A layer-by-layer polymerization-detachment-polymerization printing loop has been demonstrated for three-dimensional (3D) hydrogel microstructures fabrication. Self-rolling caused by stress mismatch provides a simple way to transform 2D hydrogel thin sheet into 3D hydrogel structures. This simple programmable micro/nanofabrication method will broaden the application of 3D hydrogel microstructures fabrication for bioengineering applications.

Keywords - micro/nanofabrication, electropolymerization, hydrogel, layer-by-layer

Paper ID : B4L-B-4 (#1066)

Fabrication of Well Aligned P(VDF-TrFE) Nanofibers with Asymmetric Comb-Shape Electrode.....478

Xuexian Chen{2}, Xiaoliang Cheng{2}, Mengdi Han{2}, Zijian Song{2}, Yonggang Jiang{1}, Haixia Zhang{2}
{1}Beihang University, China; {2}Peking University, China

This paper presents a fast fabrication process of highly aligned P(VDF-TrFE) nanofibers based on conventional far field electrospinning (CFES) technique. By attaching a comb-shape electrode onto a fast rotating drum, the process combines the advantages of plate electrode and rotating drum. The parallel electrode leads to the orientation of the deposited nanofibers, and the rotating drum further ensures it. Additionally, the high rotating speed also contributes to the fast and continuous deposition of the nanofibers. Fourier transform infrared (FTIR) spectra shows that P(VDF-TrFE) has forming crystalline of β phase. Thereby, this asymmetric comb-shape electrode with well oriented P(VDF-TrFE) nanofibers can be employed for scavenging energy from mechanical vibration and deformations.

Keywords - electrospinning, PVDF-TrFE nanofiber, energy harvesting

Paper ID : B4L-B-5 (#1171)

Fabrication of Stretchable and Flexible Vertically Aligned Carbon Nanotube Film.....482

Huan Wang, Ma-Yue Shi, Kai Zhu, Zong-Min Su, Min Zhang, Haixia Zhang
Peking University, China

This paper presents a cost-effective method to transfer vertically aligned carbon nanotubes (VA-CNTs) with Poly(dimethylsiloxane) (PDMS). We take advantage of PDMS solution as the transfer medium in this process, meanwhile we utilize the good wetting of PDMS solution on another cured PDMS film to realize efficient transfer. Applying this fabrication, we obtain VA-CNTs film with notable stretchability and flexibility. Scanning electron microscope (SEM) has been taken to characterize the surface properties, and verify the quality of transferred CNTs. This well aligned PDMS films with proper as-grown CNTs have a broad potential to be utilized in numbers of novel nanodevices, such as gas sensor, supercapacitor and nanogenerator, etc

Keywords - VA-CNTs,PDMS solution, efficient transfer, strectchability, flexibilty

B4L-C

Student paper award session

3:10 PM - 4:10 PM, April 19, 2016 Room C (HAGI, 1F)

Masaya Toda, Tohoku University (Chair)

Paper ID : B4L-C-1 (#1094)

Thermally Robust Coupled Mode at Mid IR Mediated by Highly Dense Plasmonic Nanostructure.....486

Dihan Hasan, Prakash Pitchappa, Chong Pei Ho, Chengkuo Lee
National University of Singapore, Singapore

We report the first thermal study of a coupled mode at mid IR wavelength (MW IR) on the platform of a highly dense plasmonic nanostructure. The multi-physics study is consist of broadband Fourier transform infrared (FTIR) spectroscopy interfaced with an adiabatic system for heat flow control. A hybridized coupled mode is excited by mixing the structure's plasmonic resonance with the vibrational resonance of PMMA at 5.79μm. The study unveils the thermal robustness of the coupled mode intensity under repeated heating cycle. Further investigation reveals the role of surface current engineering and mode detuning on achieving the robust characteristics. Finally, the large spatial overlap on the dense nanostructures is found to preserve the resonance contrast (45%) even under repetitive resistive heating, line width broadening and thermal degradation of the composite device.

Keywords - Bow-tie, coupled mode, electromagnetically induced transparency (EIT), thermal degradation, thermoplasmonics

Paper ID : B4L-C-2 (#1031)

Impedimetric Quantification of the Density of Suspending Trichomonas Vaginalis.....490

Ming-Jei Chen, Chia-Hao Huang, Kin Fong Lei, Wei-Hung Cheng, Petrus Tang
Chang Gung University, Taiwan

To investigate the chemosensitivity of T. vaginalis under tested drug, quantification of the density of T. vaginalis is necessary to study its viability. However, because T. vaginalis is suspended in the medium, microscopic quantification is not practical. In this work, impedimetric quantification of T. vaginalis was demonstrated using a biosensor. Investigations of impedance spectrum, sample loading volume, and correction between impedance magnitude and density of T. vaginalis were reported. Results showed the feasibility of the quantification of suspending cells based on impedance measurement technique. With the advantage of microfluidics technology, quantification of suspending cells can be completed in less sample volume (30 μl) and fast response (a few seconds). The present work has high potential to apply for the study of the development of therapeutic drug of T. vaginalis.

Keywords - Impedance measurement, Interdigated electrodes, Bacteria count

Paper ID : B4L-C-3 (#1184)

Probing Crystallography-Induced Anisotropy and Periodic Property of Atomic Friction in MoS_2 via Fast Fourier Transform Processing.....494

Meng Li, Lianqing Liu, Niandong Jiao, Peng Yu, Ning Xi, Yuechao Wang
Shenyang Institute of Automation, China

An theoretical and experimental study on friction anisotropy and 120 degree periodicity variation in atomic friction of MoS_2 is presented in this paper. To clearly clarify these properties , fast Fourier transform(FFT) is utilized by Matlab software to perform the frequency variation of the actual friction signal wave acquired from the lateral friction experiment. Characteristic of the computed frequency ratios periodically varying with lattice orientation is clearly observed and well explained in terms of the periodical variation in atomic friction. The consistency between the theoretical analysis and experimental result ultimately verify the validity of the assumption. The discovery of this paper promises future application in real-time crystallographic orientation detecting

Keywords - MoS_2, crystallography-induced anisotropy, periodic property

Paper ID : B4L-C-4 (#1287)

Piezoelectric PVDF Fiber Tubes Using Near-Field Electrospinning with Flexible Package.....N/A

Cheng-Tang Pan{2}, Shao-Yu Wang{2}, Chung-Kun Yen{2}, Yan-Cheng Lai{2}, Chih-Hao Tsao{2}, Shin-Pon Ju{2}, Shiao-Wei Kuo{2}, Liwei Lin{3}, Ying-Chieh Lin{1}, Zong-Hsin Liu{1}, Zhing-Han Hong{1}
{1}Metal Industries Research and Development Centre, Taiwan; {2}National Sun Yat-Sen University, Taiwan; {3}University of California at Berkeley, United States

This study presents a method to fabricate piezoelectric polyvinylidene fluoride (PVDF) fiber tubes. Near-field electrospinning (NFES) process with a metallic coaxial needle injector was designed to fabricate piezoelectric PVDF fiber tubes. The fiber tubes were obtained with two accurate flow syringe pumps and go through repolarization process. The PVDF fiber tubes were packaged in polydimethylsiloxane (PDMS) with flexible interdigitated electrode (IDE) to detect the voltage and current. X-ray diffraction (XRD) was conducted to compare the crystallization of PVDF powder, solid fiber, and fiber tubes. Then the open circuit voltage output of max. 0.17 V was reached with low frequency.

Keywords - piezoelectric, polyvinylidene fluoride (PVDF), fiber tubes, near-field electrospinning

B4L-D
2D Materials and Their Application
3:10 PM – 5:00 PM, April 19, 2016 Room D (TOKIWA, B1F)
Seiji Akita, Osaka Prefecture University (Chair)
Ryo Nouchi, Osaka Prefecture University (Co-Chair)

Paper ID : B4L-D-1 (#1005)

INVITED TALK
Metallic Electrode Contacts to Layered Semiconductors.....N/A

Ryo Nouchi
Osaka Prefecture University, Japan

The operation of semiconductor electronic devices such as field-effect transistors is largely governed by metal/semiconductor interfaces where charge carriers (electrons or holes) are injected from the metallic electrode into the semiconductor channel. A total electric resistance of a semiconductor device is expressed by a summation of the semiconductor channel resistance and the parasitic electrode contact resistances. In a short channel device, the channel resistance is very small, and the contact resistance becomes a dominant contribution instead. The magnitude of the contact resistance is determined by a nature of the charge injection process. Therefore, a proper understanding of the metal contact is crucially important especially for highly

integrated circuits consisting of billions of short channel devices. This talk will focus on metallic electrode contacts to emergent ultrathin sheets obtained from exfoliation of layered crystals. This class of materials is now regarded as a promising channel material for post-Si electronics. Specifically, transition metal dichalcogenides as a semiconductor and bilayer graphene with a tunable band gap will be treated in this talk.

Keywords - Metal Contact Resistance, Transition Metal Dichalcogenide, Bilayer Graphene, Charge Injection Barrier, Edge State

Paper ID : B4L-D-2 (#1352)

INVITED TALK

Synthesis of Multi-Layer h-BN by Chemical Vapor Deposition.....N/A

Daiyu Kondo, Kenjiro Hayashi, Masako Kataoka, Taisuke Iwai, Shintaro Sato
Fujitsu Laboratories Ltd., Japan

Two dimensional materials including graphene are promising materials for future LSIs due to their excellent physical properties. Hexagonal boron nitride (h-BN), which is also one of such two dimensional materials, is well known as a candidate for an insulating layer for graphene transistors [1]. Although synthesis of single-layer and/or few-layer h-BN has been reported recently [2-4], there are hardly any results regarding multi-layer h-BN, which is favorable for the insulating layer for graphene. Here, we demonstrate synthesis of multi-layer h-BN with a thickness of a few nanometer by chemical vapor deposition. Iron, cobalt and copper films sputtered on sapphire substrate were used as a catalyst for comparison, and B_2H_6 and NH_3 gases were used as the source gas. In the presentation, we will show our recent progress of synthesis of h-BN in detail.

References: [1] Nat. Nanotechnol. 7 (2010) 693. [2] J. Cryst. Growth 47 (1979) 245. [3] Langmuir 28 (2012) 1775. [4] Nano lett. 15 (2015) 1867.

Keywords - h-BN, CVD, graphene

Paper ID : B4L-D-3 (#1030) Withdraw

Paper ID : B4L-D-4 (#1236)

Synthesis of Tungsten Sulfide Crystals on SiO_2, Graphene and Boron Nitride Substrates.....N/A

Golap Kalita, Amutha Thangaraja, Sachin Maruti Shinde, Masaki Tanemura
Nagoya Institute of Technology, Japan

Here, we demonstrate synthesis of tungsten sulfide (WS_2) crystals on SiO_2, graphene and boron nitride (h-BN) substrates by sulfurization of tungsten oxide and halide (WO_3 and WCl_5) precursors. We observed that the quantity and distribution of tungsten precursor materials on the substrate surface significantly affect the nucleation and layer numbers of triangular- shaped WS_2 crystals. Again, it has been observed that the WS_2 crystals geometry evolve with shape and size of the nuclei on the substrates. Monolayer WS_2 crystals of the size 70 μm are obtained on the SiO_2/Si substrate.

Keywords - Tungsten sulfide, Graphene, Boron nitride, Sulfurization, Monolayer

Paper ID : B4L-D-5 (#1170)

Electrical Characteristics of TMDCs Based FET Attended by the Bio Molecules Adsorption.....N/A

Nguyen Tat Trung{2}, Tadahiro Komeda{2}, Atsushi Ando{1}
{1}National Institute of Advanced Industrial Science and Technology, Japan; {2}Tohoku University, Japan

Molybdenum disulfide (MoS_2) is a layered semiconductor material. The characteristic is high mobility and ultrathin in addition to basic semiconductor properties. The biosen-sor made from MoS_2 based field effect transistor (FET) is promised rapid electrical detection, without labeling the biomolecules, micro-nanoscale, low power consumption, inexpensive mass production. In our work, back gate MoS_2 was fabricated. Back gate FET structure has opened active channel. It can be used for sensing region. As a result the threshold voltage of drain current vs. gate voltage curve was shifted to negativity. It means the charge of dopamine molecules was detected. Possibility of MoS_2 FET for DA sensor was demonstrated.

Keywords - TMDS, FET, Bio sensor, Dopamine

Paper ID : B4L-D-6 (#1149)

Bent Carbon Nanotube Mechanical Resonator with Controlled van-der-Waals Interaction.....N/A

Atsuko Nagataki, Kuniharu Takei, Takayuki Arie, Seiji Akita
Osaka Prefecture University, Japan

We demonstrate the modulation of resonance properties of carbon nanotube mechanical resonator by using the van-der-Waals interaction, which can be modified by the bending of the nanotube. The bending of the nanotube induces the lowering of effective spring constant. Furthermore, the nonlinear oscillation is developed even under the small vibration amplitude corresponding to the thermal vibration.

Keywords - carbon nanotube, mechanical resonator, van-der-Waals interaction, nonlinear effect

B4L-E

Nanophotonics/Microoptics 1

3:10 PM - 4:25 PM, April 19, 2016 Room E (SUEHIRO, B1F)

Kentaro Iwami, Tokyo University of Agriculture and Technology (Chair)

Yoshiaki Kanamori, Tohoku University (Co-Chair)

Paper ID : B4L-E-1 (#1196)

Experimental Demonstration of Wavelength-Selective Metamaterial Absorbers in the 1.5 THz Range.....N/A

Yuta Ishii{2}, Yoshiaki Kanamori{2}, Kazuhiro Hane{2}, Yuma Takida{1}, Hiroaki Minamide{1}
{1}RIKEN, Japan; {2}Tohoku University, Japan

We fabricated cut-wire type metamaterial absorbers with various wire lengths and measured the absorption spectra in the 1.5 THz range. In addition, the optical characteristics were numerically investigated. The cut-wire type metamaterial absorber consisted of an Au ground layer, a polyimide layer, and an Au metamaterial layer. Due to interference of surface plasmon polariton waves in the metamaterial absorber, an incident light was efficiently absorbed. The interference conditions were mainly controlled by the wire lengths. As a result, the metamaterial absorbers absorbed terahertz waves with wavelength selectivity. Larger than 90% of absorption was obtained around 1.5 THz.

Keywords - metamaterial, plasmonics, terahertz, absorbers

Paper ID : B4L-E-2 (#1077)

Birefringence Modulation of Thermally-Driven Plasmonic Grating.....N/A

Takashi Shimura, Norihiro Umeda, Kentaro Iwami
Tokyo University of Agriculture and Technology, Japan

This paper reports a novel optical phase modulator that combines plasmonic nanograting metasurface and MEMS bimorph actuators. The plasmonic nanograting consisting of thermally-driven Au/SiO_2 bimorph beams is developed that modulate birefringence at visible wavelength. As the interleaved beams are actuated by Joule heating, effective thickness of nanoslits between Au beams is adjusted. The phase difference of fabricated modulator was measured at the wavelength range of from 500 to 800 nm. Phase modulation is obtained by current-induced Joule heating, and the maximum variation is 3.4 degree at 650 nm with a driving voltage of 1.48 V. The maximum drive current is 70.0 mA. Because of modulation characteristics and the small scale, this device is expected to be applied as a new optical device i.e. spatial light modulator.

Keywords - Phase modulation, Metasurface, Nanoslit, Birefringence, MEMS

Paper ID : B4L-E-3 (#1248)

Virtual Biopsies with a MEMS Scanner Based Confocal Microscope.....N/A

Satjana Pattanasak{2}, Wibool Piyawattanametha{1}
{1}King Mongkut's Institute of Technology Ladkrabang, Thailand; {2}Valaya Alongkorn Rajabhat University, Thailand

Confocal microscopy has been provided a powerful disease diagnosis with three-dimensional imaging capability since late 1980's. However, main limitation of this imaging modality is in the utilization of a high numerical aperture lens resulting in a small field of view and a short working distance. Here, we presented a MEMS scanner based confocal microscope that circumvents the aforementioned limitations. As a result, this miniature microscope can provide imaging access to variety tissues both ex vivo and in vivo. The microscope has a small form factor (10 mm diameter) and is capable of demonstrating three-dimensional imaging (over 200 um in axial translation).

Keywords - confocal, microscopy, MEMS scanner, imaging

Paper ID : B4L-E-4 (#1256)

Calibration System of Optoelectrical Characteristics of Micro/Nano Photodetectors.....N/A

Gongxin Li{1}, Wenxue Wang{1}, Yuechao Wang{1}, Wenguang Yang{2}, Lianqing Liu{1}
{1}Shenyang Institute of Automation, China; {2}Shenyang Institute of Automation / University of Chinese Academy of Science, China

The optoelectrical performance is the essential characteristic of photodetectors, and accurate calibration of optoelectrical characteristics is critical for the innovation and the development of photodetectors. However, the conventional method that calibrates the optoelectrical characteristics of photodetectors using a light with adjustable powers is very expensive to perform and its accuracy is low due to the inaccurate regulation of light power. In this paper, a calibration system of optoelectrical characteristics of photodetectors at micro/nano scale based on Digital Micromirror Device (DMD) was established. With the system the light powers illuminated on the photodetectors are adjusted by different control images, which determine the number of the micromirrors of DMD positioned at +12° to reflect the light onto the photodetectors. The system with a simple optical architecture can converge the testing light reflected from the DMD onto the photodetector at the micro/nano scale and the calibration accuracy is determined by the number of micromirrors of DMD at +12. Here, the theoretical calibration accuracy is up to 10^{-5} uA/uW. Different micro/nano photodetectors were utilized to evaluate the calibration effectiveness of the proposed system.

Keywords - Calibration System, Optoelectrical Characteristics, Micro/Nano Photodetectors

Paper ID : B4L-E-5 (#1322)

Wavelength-Selective Transmission from Plasmonic Nanostructured Arrays in the Visible Region.....N/A

Daisuke Ema, Yoshiaki Kanamori, Kazuhiro Hane
Tohoku University, Japan

We fabricated plasmonic color filters that consist of Al nano-slit or nano-dot arrays on SiO_2 substrates. The structural dimensions were designed and their transmittance characteristics were investigated numerically. Measured optical characteristics were compared with calculated values. In the visible region, wavelength-selective transmission peaks appeared and were worked as color filters tuned by periods of the structures.

Keywords - Wavelength-selective filters. Color filters. Surface plasmon. Metamaterial

C0L-A
Special Talk
8:55 AM - 9:20 AM, April 20, 2016 Room A (FUJI, 1F)
Shuji Tanaka, Tohoku University (Chair)
Masaya Toda, Tohoku University (Co-Chair)

Paper ID : C0L-A-1

The SLiT-J Project: Promising Tool for Science, Technology & Innovation of the Nano-Disciplines.....N/A
Masaki Takata
Executive Advisor to the President : SLiT-J Project
Tohoku University

Advanced Synchrotron Radiation (SR) has been recognized as a premier research tool for developments of nano Science and Technology. Large-scale SR facilities around the world constantly evolved to provide super brilliant and superdirective X-ray and has built a new range of applications of the nano-disciplines. Soon after the Great East Japan Earthquake in 2011, a low emittance 3GeV SR facility, Synchrotron Light in Tohoku (SLiT-J), has been projected. The primary target of the project is to achieve single nanometer scale resolution imaging as a “Super Light Source for Industrial Technology”. A unique concept of industry-academy alliance for SR application, “Coalition Concept”, is also arising out of the dialogue with industries and professors about outlook of SLiT-J. The latest status and the perspectives on the project will be presented.

C1L-A
Bio & medical devices
9:30 AM - 10:45 AM, April 20, 2016 Room A (FUJI, 1F)
Masanori Muroyama, Tohoku University (Chair)

Paper ID : C1L-A-1 (#1087)

MEMS Oxygen Transport Device for Islet Transplantation in the Subcutaneous Site.....499
Dongyang Kang{1}, Hirotake Komatsu{2}, Henry Lin{2}, Colin Cook{1}, Yu-Chong Tai{1}, Yoko Mullen{2}, Fouad Kandeel{2}
{1}California Institute of Technology, United States; {2}City of Hope, United States

This paper presents a new MEMS approach of maintaining islet oxygenation for subcutaneous islet transplantation therapy of type 1 diabetes by engineering a MEMS oxygen transport device. A device is designed and fabricated. Bench-top testing and computational modeling of the device have demonstrated that it would provide sufficient oxygen to prevent hypoxia-induced islet death and maintain the functional metabolic activity of glucose-simulated insulin secretion of islets transplanted subcutaneously.

Keywords - type 1 diabetes, islet transplantation, hypoxia, MEMS oxygen transport device

Paper ID : C1L-A-2 (#1123)

Recording of Electoneurograms Signals by Self-Adaptive Neural Ribbon Electrode on Distal Nerve Branches for Electroceuticals.....N/A

Zhuolin Xiang, Chengkuo Lee
National University of Singapore, Singapore

Various flexible peripheral nerve interfaces have been developed in the last decades and transferred into neuroscientific researches or clinical applications. In this study, we present a novel flexible neural ribbon electrode with self-adaptive feature for nerves with various diameters. This device first time realizes implantation on the rat sciatic nerve branches. The recording capability of the neural ribbon on small nerves with different diameter was demonstrated by signal acquisitions from sciatic nerve, peroneal nerve, tibial nerve and sural nerve, respectively.

Keywords - Flexible electrodes, neural interfaces, implantable bioMEMS, electroceuticals

Paper ID : C1L-A-3 (#1194)

Micro Flow Sensor Integration Onto Basket Forceps for Pulmonary Function Evaluation.....N/A

Naoaki Harada{1}, Ryota Ono{2}, Miyoko Matsushima{2}, Tsutomu Kawabe{2}, Yoshihiro Hasegawa{1}, Mitsuhiro Shikida{1}
{1}Hiroshima City University, Japan; {2}Nagoya University, Japan

We integrated micro-machined thermal flow sensor onto a commercialized basket forceps, as a new sensing system in respiratory diagnosis. At first, the thermal flow sensor was fabricated onto a thin polyimide film by micro-electro-mechanical systems (MEMS) technologies, and then it was mounted onto a part of a guide tube in the basket forceps. Two physical values; flow velocity and direction were detected by the two heaters made of Au on the film. The sensor output versus flow rate was closely matched with theoretical model. Finally, the developed sensor was inserted into a narrow tube, and was firmly fixed to inner wall by bending arms of the basket forceps. We also confirmed the developed flow sensor could be successful in detecting the breathing waveform of rat.

Keywords - Flow Sensor, COPD, Basket Forceps

Paper ID : C1L-A-4 (#1207)

MEMS Artificial Neuromast Arrays for Hydrodynamic Control of Soft-Robots.....504

Ajay Giri Prakash Kottapalli{3}, Mohsen Asadnia{4}, Zhiyuan Shen{3}, Vignesh Subramaniam{3}, Jianmin Miao{2}, Michael Triantafyllou{1}
{1}Massachusetts Institute of Technology, United States; {2}Nanyang Technological University, Singapore;
{3}Singapore-MIT Alliance for Research and Technology, Singapore; {4}University of Western Australia, Australia

There is a high demand for miniaturized, low-powered, light-weight and robust sensors that can perform sensing on underwater robotic vehicles (URVs) to improve their control and maneuverability. In this work, we present the design, fabrication, packaging and experimental testing of two types of bio-inspired MEMS sensors. We demonstrate the development of flexible arrays of piezoresistive all-polymer sensors that perform steady-state flow-sensing analogous to the superficial neuromasts (SNs), and arrays of piezoelectric pressure sensors which perform hydrodynamic oscillatory flow sensing similar to the canal neuromasts (CNs). For the first time, in this paper, we demonstrate the real-time application of neuromast-inspired MEMS flow sensors in performing hydrodynamic flow sensing to achieve improved control of soft robots. Experimental tests conducted underwater by mounting the sensors on lab-built robotic fish tail and stingray validate the arrays' ability in accurately detecting the propagation velocity and flapping hydrodynamics of the robots. Real-time experiments conducted on a kayak show that the sensors detect vortex-shedding signatures that could lead to energy-efficient maneuvering.

Keywords - Biomimetic, MEMS, flow sensing, polymer MEMS, hydrodynamic sensing

Paper ID : C1L-A-5 (#1185)

Octopus Bioinspired Vacuum Gripper with Micro Bumps.....508

Tomokazu Takahashi, Masato Suzuki, Seiji Aoyagi
Kansai University, Japan

This paper describes an octopus bioinspired vacuum gripper for transportation or assembly of industrial parts. The previous gripper can grasp the object with flat, curvature, uneven, and grooved surface. However, octopus has the microstructure on suction cup, for example, cylindrical and radial grooves and micro bump. These structure is expected to improved flexibility and adhesive force of suction cup. Therefore, we evaluated the performance of octopus bioinspired gripper with micro bump of 2 micrometer in diameter and 4 micrometer in pitch. Using micro bump, The adhesive force is increased. Moreover, adhesive area is kept circle shape, since the friction force is increased by the micro bumps.

Keywords - bioinspired robot, octopus, vacuum gripper, micro bump, silicone

C1L-B
Fabrication of functional materials
9:30 AM - 10:55 AM, April 20, 2016 Room B3 (CHIYO 3, 1F)
Motoaki Hara, University of Texas at Dallas (Chair)

Paper ID : C1L-B-1 (#1142)

INVITED TALK

Advanced PZT-Based Epitaxial Thin Film on Si for High Performance Piezoelectric MEMS.....N/A

Shinya Yoshida{1}, Kiyotaka Wasa{2}, Shuji Tanaka{1}
{1}Tohoku University, Japan; {2}Yokohama-City University, Japan

Advanced MEMS sensors are expected to be developed for future applications such as precise navigation for individual person and aviation, autonomous control of automobile, control and navigation of personal vehicle, motion control of robot etc.. Piezoelectric MEMS has a great potential to provide high performance vibratory MEMS gyroscope and ultrasonic range finder utilized for these applications. As one of the most suitable piezoelectric transducer thin films, we have developed the sputter deposition technology of a highly c-axis oriented 0.06Pb($Mn_{1/3}$,$Nb_{2/3}$)O_3-0.94Pb($Zr_{0.5}$,$Ti_{0.5}$)O_3 (PMnN-PZT) epitaxial thin film on a Si substrate. High c-axis orientation ratio more than 75% was obtained by fast cooling after sputter deposition. The films exhibited a relatively large piezoelectric coefficient, e_{31f} = ~ -14 C/m^2, and a quite small dielectric constant, ε_{r33} = ~200. As a result, a figure of merit for MEMS gyroscope and ultrasonic transducers, $(e_{31f})^2/\varepsilon 0\varepsilon r33$, reached ~110 GPa, which is the highest value ever reported for piezoelectric thin films on Si. This epitaxial PMnN-PZT/Si transducer promises to be applied to the advanced piezoelectric MEMS.

Keywords - PZT, piezoelectric MEMS, gyroscope, ultrasonic transducer

Paper ID : C1L-B-2 (#1225)

Lamb Wave Resonators and Resonator Filters in Periodical Poled Z-cut $LiTaO_3$ Plate.....512

Michio Kadota{2}, Takashi Ogami{1}, Kansho Yamamoto{1}, Yasuo Cho{2}, Shuji Tanaka{2}
{1}Murata Manufacturing, Japan; {2}Tohoku University, Japan

A periodical poled (PP) plate looks like a cross-field model by Smith of an interdigital transducer (IDT) to generate a surface acoustic wave (SAW). Therefore a top-electrode/PP-plate/bottom-electrode has a possibility to generate an acoustic wave. However, the structure generates a plate wave and doesn't SAW, because the plate is not thick compared with a poling pitch. Although SAW resonator devices require grating reflectors at both sides of an IDT, PP-plate devices cannot fabricate the grating reflector, because they don't have electrode fingers. Utilizing an effective reflector using edge reflections on the PP-plate instead of grating reflectors used in SAW resonators, authors fabricates Lamb wave resonators with different propagation length

corresponding IDT finger pairs and resonator filters with different propagation direction on PP Z-$LiTaO_3$ plates. As a result, resonators with impedance ratio of 34 dB and resonator filters with low loss of 2.4 dB were obtained.
Keywords - Lamb wave, periodical poled plate, Z-cut $LiTaO_3$, resonator, resonator filter, edge reflection

Paper ID : C1L-B-3 (#1249)

Fabrication and Characterization of Lithium-Niobate Thin Film MEMS Piezoelectric Resonators.....516

Wei-Siang Tan, Grace Fang, Gayathri Pillai, Cheng-Chi Chen, Chao-Yu Chen, Chi-Hang Chin, Sheng-Shian Li
National Tsing Hua University, Taiwan

This work uses single crystal X-cut thin film Lithium Niobate (LN) resonators operating in the shear horizontal (SH0) acoustic plate wave mode to achieve a high electromechanical coupling coefficient. In the fabrication process, we use off-the-shelf single crystal X-cut LN die on which surface micromachining technology is used to fabricate the devices. We design two fabrication process flows and they are roughly divided into three parts. The first part is photolithography, primarily responsible for defining the electrodes and etching holes; this process for fabrication uses two masks. The second part is LN Reactive Ion Etching (RIE) process that defines the device edges. The third part is to etch the silicon dioxide beneath. Wet Hydro Fluoric (HF) chemistry is used to release the thin film structure. This study also reports measurement results of the SH0 mode LN resonator with the high electromechanical coupling coefficient of 15.8%.
Keywords - Electromechanical coupling coefficient, Lithium Niobate, Shear horizontal acoustic plate wave mode, Surface micromachining, Reactive Ion Etching

Paper ID : C1L-B-4 (#1143)

Development of a Simple Fabrication Process for a Printable Piezoelectric Energy Harvest Device.....520

Yuki Kamata{4}, Donghyun Yoon{4}, Toshio Sasaki{2}, Yoshito Nozaki{4}, Shinichi Yamaura{1}, Testushi Sekiguchi{4}, Takashi Nakajima{3}, Shuichi Shoji{4}
{1}Polytechnic University, Japan; {2}Tohoku University, Japan; {3}Tokyo University of Science, Japan; {4}Waseda University, Japan

This paper presents the study on piezoelectric (VDF/TrFE) energy harvest device fabricated by novel printing process. The fabrication process using metal nano-ink and household printer reduced the production complexity and fabrication time dramatically. Additionally, this low temperature process could avoid structural defects, which were coursed over annealing of the polymer, and generate high output voltage. About 100V of electricity was generated by the printable piezo device.
Keywords - Energy harvest, Printable electronics, Piezoelectric, VDF/TrFE

Paper ID : C1L-B-5 (#1286)

Sharp-Edged Templates for Imprinting of Ceramic Green Sheets.....N/A

Keisuke Nagato, Yoshito Fujiwara, Arata Sakai, Masayuki Nakao
University of Tokyo, Japan

For imprinting a ceramic green sheet, sharp-edged mold was fabricated from a sharp-edged template. The template was fabricated by anisotropic etching quartz substrate with hydrofluoric acid. The microstructure of the template was transferred to polymethyl-methacrylate (PMMA) film by thermal imprinting and the microstructure on the PMMA film was replicated to a Ni mold by electroplating.
Keywords - Ceramics, Imprinting, Green sheet, Template

C1L-C
Molecular Sensors 2
9:30 AM - 10:45 AM, April 20, 2016 Room C (HAGI, 1F)
Congo Tak Shing Ching, National Chi Nan University (Chair)

Paper ID : C1L-C-1 (#1237)

Fabrication of ZnO Thin Film Sensor for Mis Flexible Force Feedback Device.....524

Shih-Chi Chan{1}, David T.W. Lin{2}, Kai-Che Jack Liu{1}, Jing-Jim Ou{1}, Ashwin Verma{2}
{1}Chang Bing Show Chwan Memorial Hospital, Taiwan; {2}National University of Tainan, Taiwan

A flexible MIS(Minimally Invasive Surgery) force feeback sensor is a prospective technology for the extensive application of a Piezoelectric device. The purpose of this study was to know the crystallization of ZnO film for MIS force feeback sensor by sol-gel technology and spin coating. The center of operating frequency of this SAW MIS force feeback sensor was measured by the vector network analyzer. The results showed that a significant deviation of frequency resulted from the performance of AlN Doped ZnO. Characteristics of the piezoelectric MIS force feedback sensor was thin, portable and flexible. The improvement of fabricated parameters may enhance the effect of sensing of this MIS force feeback sensor.

Keywords - ZnO thin film, sol-gel method, MIS force feedback sensor

Paper ID : C1L-C-2 (#1039)

Real-Time Impedimetric Quantification of the Formation Process of Cancer Cell Colonies.....N/A

Bo-Yuan Lin, Kin Fong Lei, Chia-Hao Huang
Chang Gung University, Taiwan

In cancer research, colony formation assay is a gold standard for the investigation of the development of early tumors and the effects of cytotoxic agents on tumors in vitro. However, it is challenging to microscopically quantify the colony number and size without subjective bias. In this study, a biochip incorporating with material regulation technology was developed for real-time monitoring of the formation process of cancer cell colonies. The biochip has the advantages including: (1) On-chip cancer cell colony formation; (2) Real-time impedimetric quantification of the formation process of cancer cell colonies; (3) Test of cytotoxic agents on tumors in vitro. The current work provides quantitative and objective information to describe the cancer cell colonies during culture course.

Keywords - Impedance measurement, Cancer cell colonies, Colony formation assay, Drug test

Paper ID : C1L-C-3 (#1054)

A Sub-Micron CMOS-Based ISFET Array for Biomolecular Sensing.....528

Yu-Han Sun{1}, Guan-Yin Chen{1}, Chih-Ting Lin{1}, Jui-Cheng Huang{2}, Yu-Jie Huang{2}, Chin-Hua Wen{2}
{1}National Taiwan University, Taiwan; {2}Taiwan Semiconductor Manufacturing Company, Taiwan

A CMOS-based ion-sensitive field-effect transistor (ISFET) is designed, fabricated, and validated as a biosensor for protein diagnosis. Utilizing 180 nm foundry process, this work experimentally demonstrates the developed dual-gated ISFET biosensor array (128 by 128 devices) has capabilities to obtain statistical measurements of pH. Furthermore, it can be used to detect two specific biomarkers, i.e. cTnI and HbA1c, for cardiac diseases and diabetes respectively. This work shows benefits of the nano-scale ISFET array for biosensing applications.

Keywords - ISFET, sensor array, cTnI, HbA1c, biosensor

Paper ID : C1L-C-4 (#1203)

Ultrathin (~10nm) InN Resistive Gas Sensor for Selectivity of Breath Ammonia Gas by Using Temperature Modulation.....532

Sujeet Kumar Rai, Kun-Wei Kao, Shang-Jr Gwo, J. Andrew Yeh
National Tsing Hua University, Taiwan

The advancement of epitaxial growth techniques of ultrathin InN crystalline has opened new opportunities to develop miniaturized selective gas sensors for the breath ammonia gas. The high quality (~ 10 nm) ultrathin InN coated with Pt catalytic layer have been fabricated for selective detection of breath ammonia gas by using temperature modulation technique for liver disease application. Temperature modulation technique is very effective method to enhance selectivity of gas sensor. We are using staircase temperature programming from (200 °C to 0 °C to 200 °C) and from (175 °C to 210 °C to 175 °C) for a single InN gas sensor can achieve the selectivity of ammonia gas, each temperature region act as virtual sensor, InN gas sensor will give different response in different temperature region. Percentage change in current in each temperature region is key factor to improve the selectivity of ammonia gas.

Keywords - Gas Sensor, selectivity, MBE, Sensitivity, Temperature modulation,

Paper ID : C1L-C-5 (#1173)

Near-Field Assisted White Light Interferometry for Three Dimentional Super Resolution Imaging.....N/A

Feifei Wang{2}, Pan Li{2}, Haibo Yu{2}, Lianqing Liu{2}, Wen Jung Li{1}
{1}City University of Hong Kong, Hong Kong; {2}Shenyang Institute of Automation, China

We propose a high-throughput three-dimensional super-resolution microscopy method "near-field assisted white light interferometry (NFWLI) " which can realize sub-diffraction limited resolution in all three dimensions by transforming near-field information into far-field and then record the interference of the transformed evanescent waves and reference waves. Resolving structures in central processing units (CPUs) with minimal feature of ~ 50 nm in the lateral dimensions and ~ 10 nm in the axial dimension within 25 s (40 times faster than a traditional atom force microscope) has been demonstrated. We will report the principles of operation of this system and show its full capability at the conference.

Keywords - Near field, Evanescent waves, Microsphere, Superlens, Super resolution, White light interferometry

C1L-D

Nanocarbon based Devices and Systems 1

9:30 AM - 10:30 AM, April 20, 2016 Room D (TOKIWA, B1F)

Daiyu Kondo, Fujitsu Laboratories (Chair)

Seiki Akita, Osaka Prefecture University (Chair)

Paper ID : C1L-D-1 (#1040)

Highly Compressible Solid-State Supercapacitor with Folded Paper-Based Electrode.....536

Yu Song, Xiaoliang Cheng, Haotian Chen, Mengdi Han, Xuexian Chen, Haixia Zhang
Peking University, China

This paper presents a novel solid-state compressible supercapacitor with the folded carbon-nanotube (CNT)/paper electrode. Both of the compression tolerance of folding structure and the strain capability of CNT films play important roles in this electrode, leading to their high compression-tolerant ability, which can be widely used in different environments. Such solid-state supercapacitor was fabricated with compressible folding electrodes and PVA/H_3PO_4 as solid-state electrolyte, the specific capacitance of which reaches 11.07 mF/cm^2, and capacitance retention retains more than 90% after 100 cycling tests. In addition, the performance of as-prepared supercapacitor is very stable when compressed under 50% strain, which enlightens a broad field of compressible energy storage devices to be compatible with high compression-tolerant electronics.

Keywords - paper-based, compressible, supercapacitor, carbon nanotube

Paper ID : C1L-D-2 (#1222)

Experimental Determination of the Rate of Water Filling of Large Diameter Carbon Nanotubes.....540

Gregory Pilgrim
Kyoto University, Japan

Water filling of carbon nanotube bores in the 4-15 nm diameter range is experimentally evaluated by means of tracking proton transport through a carbon nanotube membrane. A membrane with empty bores is installed between to reservoirs, one containing a significant concentration of free protons. Water fills nanotube bores allowing for voltage-motivated transport of protons from a region of high concentration to a region of low concentration, which is monitored by means of a pH indicator. Overall rate of proton transport can be broken into two components " the rate of water filling empty bores and the rate of proton transport through those bores.

Keywords - carbon nanotubes, water, confined

Paper ID : C1L-D-3 (#1059)

Rapid Thermal Annealing for Carbon Nanotube Thin Film Transistors by a Double-Themral-Region Furnace.....545

Chun Chen, Yanyan Deng, Peijian He, Min Zhang
Peking University, China

Rapid thermal annealing (RTA) in hydrogen followed by rapid cooling down with a double-thermal-region movable CVD for carbon nanotube thin film transistors (CNT-TFTs) has been proved to be an effective method to improve device performance. After the post-treatment by RTA and rapid cooling down, off current of CNT-TFTs was reduced by 1-2 orders, on/off ratio as well as mobility were increased. It turned out that RTA treatment under 700 °C for 60 seconds resulted in the most significant improvement for CNT-TFT performance.

Keywords - CNT-TFTs, RTA, hydrogen annealing, rapid cooling, double-thermal-region CVD, metal-carbon nanotube contact

Paper ID : C1L-D-4 (#1288)

Investigation of Electrical Breakdown of Multiwall Carbon Nanotubes: Joule Heating and Electron Migration.....N/A

Bo Song, Ning Xi, Liangliang Chen, Zhiyong Sun, Yongliang Yang, Hongzhi Chen, Zhanxin Zhou
Michigan State University, United States

In this research, we investigate the mechanism of electrical breakdown of multiwall nanotube (MWNT) using the atomic force microscopy (AFM). MWNT Electrical breakdown happens when the the electron density is large enough to destroy its outer layer or entirely burn it out. During the last serval decades, in order to use MWNTs to build up nano circuit, a number of relative research has been conducted to understand the mechanism of the electrical breakdown. However, contradictory results were obtained. In this research, we use an AFM based nanorobot to investigate two different breakdown behavior: Joule heating and electron migration. The AFM based nanorobot is used to measure the resistance distribution of the MWNT to select MWNTs without structure defect and observe the topography before and after the electrical breakdown. The experimental results conclude that, Joule heating and electron migration are the reasons caused MWNT electrical breakdown, but the conditions of these two kind of electrical breakdown are various. In general, bias current (electron density) slope is the key factor to decide which kind of electrical breakdown will happen, and this conclusion will benefit for the research area like bandgap engineering and high performance nano sensor/transistor fabrication.

Keywords - Carbon nanotube, Electrical breakdown, Joule heating, Electron migration, Atomic force microscopy, Nanorobot

C1L-E
Nanophotonics/Microoptics 2
9:30 AM – 11:00AM, April 20, 2016 Room E (SUEHIRO, B1F)
Kazuhiro Hane, Tohoku Univeristy (Chair)

Paper ID : C1L-E-1 (#1121)
INVITED TALK
Nano-Electromechanically Tunable Plasmonic Resonator.....N/A
Junichi Takahara, Masashi Miyata, Hiroshi Kaijima
Osaka University, Japan
We propose and demonstrate a novel active plasmonic resonator based on a metal nanowire (NW) suspended on a metal substrate. A probe-based pick-and-place method was used by fabricating and manipulating a gold NW from a thin gold film, and then focused ion beam (FIB) was used by fixing it onto the substrate. By applying static voltage between the NW and the substrate, the suspended NW can be pull down by the electrostatic force, closing the metallic gap. This electromechanical response dramatically changes the resonant properties of the NW. We measured dark field images and the scattering spectra from the NW under white light illumination. We observed that the scattering spectra of the NW were changed by changing the voltage. The scattering spectra from the NW show gap plasmon resonance which is attributed to Fabry-Perot interference of surface plasmon inside the gap.
Keywords - plasmonics, NEMS, nanowire

Paper ID : C1L-E-2 (#1130)
INVITED TALK
Light-Induced Polymer Movement for Nano Imaging.....N/A
Hidekazu Ishitobi
Osaka University, Japan
Light-induced polymer movement was utilized to visualize optical near-field distribution in the vicinity of single gold nano-particles (GNPs) with a resolution beyond the classical diffraction limit of light. A linearly polarized (Ex) laser beam was irradiated to GNPs embedded in azo-polymers to excite local surface plasmon resonance that creates enhanced near-field. The enhanced near-field around GNPs induced polymer movement, and then the deformation patterns were measured by an atomic force microscope. We found that the patterns were dependent on both the diameter of GNPs and the polymer thickness. By comparing the theoretical calculations of near-field distributions with the deformation patterns, we found that the deformation patterns were dependent on the ratio between Ex and Ey, both of which have different field distributions.
Keywords - Light-induced mass transport, Cis-trans isomerization, Plasmon, Au nano particles, Near-field, Nano-imaging

Paper ID : C1L-E-3 (#1349)
INVITED TALK
Nano/Micro Three-Dimensional Printing and Ceramic Molding Processes.....N/A
Shoji Maruo
Yokohama National University, Japan
Recently three-dimensional (3-D) printing techniques have attracted much attention due to their ability to produce complex 3-D structures with a wide variety of materials. In particular, two-photon microfabrication using a femtosecond laser beam can provide sub-100 nm resolution due to its nonlinear property of two-photon-initiated photopolymerization [1]. Therefore two-photon microfabrication has been widely used for various kinds of applications including photonic crystals and metamaterials. We have developed optically controlled lab-on-a-chip devices such as micropumps and microtweezers [2]. In addition, metallic micromachines driven by an ultralow-power laser beam have been produced by the combination of two-photon microfabrication and electroless plating [3]. Furthermore, 3-D molding process has been developed to produce functional ceramic microparts such as transparent microchannels, bio-scaffolds and energy harvesters. In the molding process, a 3-D polymeric model produced by single-photon and two-photon microfabrication is used as a mold to insert ceramic slurry [4]. Such 3-D molding

processes will be applied for lab-on-a-chip, regenerative medicine and MEMS.
[1] Optics Letters 22, 132 (1997). [2] Lasers & Photonics Reviews 2, 100 (2008). [3] Journal of Laser Micro / Nanoengineering, 8, 6 (2013). [4] SPIE Newsroom (29 November 2012) DOI: 10.1117/2.1201211.004378.
Keywords - Thee-dimensional printing, Optical trapping, lab-on-a-chip, Ceramics

Paper ID : C1L-E-4 (#1161)

Combination of LPCVD and PECVD SiC in Fabricating Evanescent Waveguides.....549

Yu Xin, Gregory Pandraud, Lukasz Pakula, Bruno Morana, Paddy French
Technische Universiteit Delft, Netherlands

As a promising material in MEMS field, SiC is widely used to fabricate sensors in many applications. Considering its fabrication potential and optical properties, SiC is chosen as the core material of evanescent waveguide sensor in this work. LPCVD and PECVD deposition are combined in fabricating the waveguide. To reduce the coupling loss and misalignment effect, 3D tapered couplers are to be added to the input and output of the waveguide and a novel slope transfer method is investigated to fabricate the taper slope. In initial experiments we have achieved a slope of 16.7°.
Keywords - LPCVD, PECVD, SiC, waveguide, taper coupler

C1L-F
Micro/Nanomechanics and instrumentation 1
9:30 AM - 10:55 AM, April 20, 2016 Room B1 (CHIYO 1, 1F)
Etsuo Maeda, University of Tokyo (Chair)

Paper ID : C1L-F-1 (#1294)

INVITED TALK
Phonon Confinement, Transport, and Piezoelectric Manipulation in Nonlinear Electromechanical Resonators.....N/A

Hiroshi Yamaguchi, Imran Mahboob, Hajime Okamoto, Daiki Hatanaka
NTT Basic Research Laboratories, Japan

Electromechanical resonators are widely used structures which enables coherent acoustic phonons to be confined with small energy dissipation. A GaAs/AlGaAs heterostructure is one of the most ideal material systems for fabricating a high performance electromechanical parametric resonator, in which its nonlinear properties allow phonon dynamics to be controlled through external signals. We recently demonstrated the coherent manipulation of phonon dynamics, where the phonon population can be transferred between different oscillation modes [1,2]. We also realized the dynamical control of phonon transport by constructing a phononic crystal waveguide, allowing the propagation dynamics to be electrically switched [3]. The highly controllable phononic devices are promising for future applications, such like signal processing, ultrasonic imaging, functional sensing, and also the transduction of quantum information between macroscopic systems.
[1] I. Mahboob, K. Nishiguchi, H. Okamoto, and H. Yamaguchi, Nature Physics 8. 387 (2012). [2] H. Okamoto, A. Gourgout, C.Y. Chang, K. Onomitsu, I. Mahboob, E.Y. Chang, and H. Yamaguchi, Nature Phys. 9, 480 (2013). [3] D. Hatanaka, I. Mahboob, K. Onomitsu, and H. Yamaguchi, Nature Nanotechnology 9, 520 (2014).
Keywords - NEMS, MEMS, Mechanical Resonators

Paper ID : C1L-F-2 (#1200)

Mechanically Coupled Capacitive Silicon Nanomechanical Resonators.....N/A

Tsuyoshi Shimazaki, Nguyen Van Toan, Takahito Ono
Tohoku University, Japan

This paper reports on the design, fabrication and evaluation of mechanically coupled capacitive silicon nanomechanical resonators. A mechanical resonance at a high frequency of approximately 9.4 MHz has been detected, which synchronized

vibration in flexural mode. The motional resistance of the device is dramatically decreased in a comparison of single and mechanically coupled capacitive silicon nanomechanical resonators.
Keywords - nanomechanical, motinal resistance, coupled

Paper ID : C1L-F-3 (#1152)

Silicon MEMS Actuator with No Space Gap Between Driving Electrodes.....553

Tomoki Nishino, Kazuki Baba, Yuri Nakai, Hiroshi Tanigawa, Kenichiro Suzuki
Ritsumeikan University, Japan

Two kinds of new silicon actuators, cantilever and twisted-beam, based on pn diode actuation principle are presented. The space gap that is absolutely needed in conventional electrostatic MEMS actuators is replaced by a depletion layer in reversely-biased pn diode. The strong electric field generated in the depletion layer forces a silicon microstructure to vibrate. The microstructure causes a large deflection at resonance. This actuator eliminates a narrow gap between driving electrodes. Consequently, the silicon actuators maintain to be of high reliability for a long period.
Keywords - actuator, pn diode, depletion layer, resonant, microprobes, micro mirrors

Paper ID : C1L-F-4 (#1112)

Oscillator Based Surface Acoustic Wave Gyroscopes.....557

Yusuke Musha, Motoaki Hara, Hiroki Asano, Hiroki Kuwano
Tohoku University, Japan

In this paper, angular rate sensing based on surface acoustic wave (SAW) resonance was newly reported. Our gyroscope was an oscillator consisted of a single SAW resonator and an amplifier. The angular rate was obtained from the change of oscillation frequency. The SAW resonator applied to the sensor simply consisted of an interdigital transducer (IDT) and a pair of grating reflector. Any nanoscale scattering patterns or any complicate unidirectional IDTs (UDTs) were not necessary. In the demonstration of the sensor with oscillation frequency of 9.7 MHz, the sensitivity was 7.83×10^{-3} Hz /deg•s^{-1}. The SAW gyroscopes detected only the angular rate as the rotation axis was parallel to the SAW propagation direction. Also, it did not reply when the rotation axis was orthogonal. These results agreed with theoretical predictions well.
Keywords - Surface acoustic wave (SAW), gyroscope, oscillator, Sensor module

Paper ID: C1L-F-5 (#1111)

Three-Dimensional Cellular Forces Measurement Using a MEMS-Based Piezoresistive Force Sensor.....N/A

Nguyen Thanh-Vinh, Tomoki Omiya, Takuya Tsukagoshi, Kayoko Hirayama, Kentaro Noda, Kiyoshi Matsumoto, Isao Shimoyama
University of Tokyo, Japan

In this paper, we report on direct measurement of three dimensional cellular forces using a MEMS-based force sensor. Our proposed sensor consists of a photoresist micropillar on a 0.3 μm-thick cross-shaped silicon piezoresistive structure. The pillar is surrounded by another photoresist cap which results in the small gap (several μm) to prevent the cell to fall on the silicon structure. We demonstrated through experiments that the sensor can detect the dynamical forces of cells as they became detached from the micropillar.
Keywords - MEMS, force sensor, cell

C2L-A
Micro-fluidics and Nano-fluidics 3
11:10 AM - 12:35 PM, April 20, 2016 Room A (FUJI, 1F)
Manish Biyani, Nara Institute of Science and Technology (NAIST) (Chair)

Paper ID : C2L-A-1 (#1140)

INVITED TALK
Femtoliter Microdroplet Compartments for Linkage-Free in Vitro Selection Using Super-Fine Inkjet.....N/A

Manish Biyani, Bineet Sharma, Yuzuru Takamura
Japan Advanced Institute of Science and Technology, Japan

A combination of droplet technology and cell-free reaction enables to encapsulate biology in a cell-sized confined space and thus offers a means to parallelize biological/chemical assays inside of femtoliter-sized microdroplet compartments for in vitro molecular evolution and selection. However, molecular crowding can leads to the size-dependent behavior of cell-free molecular systems. We described a compartmentalized in vitro selection approach and designed a device capable of continuous generation of large-scale and highly monodisperse microbeads with volume <5 fL at the speed of 3 million per min using the application of electrostatic super-fine inkjet technology. We studied the effect of various electrical and flow parameters on the ability to generate monodispersed size droplets continuously through electro-generation by an inkjet nozzle submerged in an oil phase. An average size of 0.82 µm droplet was generated using an inkjet nozzle with 4 µm of orifice diameter at frequencies up to 1 kHz. These droplets were utilized to perform in vitro biological reactions and further exploited for in vitro selection to identify high-affinity aptamers for unreachable biomarkers.

Keywords - Inkjet, in vitro compartmentalization, aptamer, selection

Paper ID : C2L-A-2 (#1135)

An Integrated Microfluidic System for Screening of Peptides Specific to Cholangiocarcinoma (CCA) Cancer Cell Lines Using the Phage Display Technology.....561

Ching-Wen Yu{2}, Lien-Yu Hung{2}, Chien-Yu Fu{2}, Chih-Hung Wang{2}, Nai-Jung Chiang{1}, Yu-Chun Wang{1}, Yan-Shen Shan{1}, Gwo-Bin Lee{2}
{1}National Cheng Kung University Hospital, Taiwan; {2}National Tsing Hua University, Taiwan

Cholangiocarcinoma (CCA) is a cancer of bile duct, which possesses a high mortality rate and poor prognosis owing to its difficulties in early diagnosis and a lack of effective treatment. To improve the clinical detection, one of promising approaches is to find specific biomarkers to detect CCA cells. However, the screening processes are usually time-consuming and lab-intensive. In this study, an integrated microfluidic system was proposed to perform on-chip phage display for selection of specific peptides that could identify CCA cell lines. The results showed that we could perform one panning round within 6 hr and the whole processes are automated. This microfluidic system may be a powerful tool for screening of affinity agents in the clinical diagnosis and target therapeutics for CCA.

Keywords - Cholangiocarcinoma (CCA), phage display, peptide, microfluidics

Paper ID : C2L-A-3 (#1269)

Large-Scale High-Density Microarray Technology for Screening of Highly Diverse Protein Mutant Library.....N/A

Shusuke Sato{1}, Manish Biyani{2}, Shingo Ueno{1}, Ankita Jain{2}, Subasini Raji Kumal{2}, Hiromi Kuramochi{2}, Takanori Akagi{2}, Takanori Ichiki{2}
{1}Institute of Industry Promotion-Kawasaki / University of Tokyo, Japan; {2}University of Tokyo, Japan

Darwin's theory can help us to evolve and discover novel and highly functional biomolecules that will be used in various industries such as healthcare, energy, food, and chemical. In the field of directed evolution of proteins, high-throughput

quantitative screening of highly diverse protein library is a challenging issue. In order to enable the quantitative screening, it is promising to integrate the directed evolution technology into microarray screening platform. This study is aiming to improve the performance of the directed evolution based on microfabricated large-scale high-density microarray technology. This paper puts its focus on how desired functional protein are obtained from the large library by our artificial Darwinian selection technology.
Keywords - Microarray, Directed evolution, Mutant, Protein

Paper ID : C2L-A-4 (#1047)

Construction of Cell-Sized Liposomes and Droplets Toward Synthesis of Molecular Robots.....N/A

Masamune Morita, Daisuke Ishikawa, Masahiro Takinoue
Tokyo Institute of Technology, Japan

We report a centrifugal capillary-based microfluidic method for the production of cell-sized liposomes and water-in-oil (W/O) droplets. This technique does not need complicated microfabrication processes. We demonstrate the production of cell-sized liposomes and W/O droplets from a small sample volume (0.1-1 μL). We believe that this method can be applied to generate cell-sized liposomes and W/O droplets for a wide variety of uses, such as the construction of molecular robots.
Keywords - Centrifugal Capillary-based Microfluidic device, Liposomes, Water-in-oil Droplets

Paper ID : C2L-A-5 (#1212)

An Integrated Array-Based Emulsion Droplet Microfluidic Device for Digital Loop-Mediated Isothermal Amplification (LAMP) Analysis.....565

Kang Luo, Yu-Dong Ma, Wen-Hsin Chang, Gwo-Bin Lee
National Tsing Hua University, Taiwan

Loop-mediated isothermal amplification (LAMP) is a nucleic acid amplification technique which amplifies DNA with high specificity, efficiency and rapidity under isothermal conditions. In this study, a microfluidic droplet array chip is presented to implementing array-based digital LAMP analysis. The proposed microfluidic system can perform the basic operation of droplet including droplet formation, droplet immobilization, incubation and detection. This is the first time that integrates emulsion droplet microfluidic with array-based digital LAMP analysis. As compared to micro-well digital assays, this droplet array-based digital assay eliminates the constraint on the size of the digitized target. Moreover, the employment of hydrodynamic trapping allows for one-droplet-to-one-trap. This microfluidic chip may become a promising device for digital LAMP based clinical diagnosis.
Keywords - emulsion droplet, hydrodynamic trapping, digital LAMP

C2L-B
Application of nano/micro structures
11:10 AM - 12:25 PM, April 20, 2016 Room B3 (CHIYO 3, 1F)
Kentaro Iwami, Tokyo University of Agriculture and Technology (Chair)

Paper ID : C2L-B-1 (#1060)

Stretchable Transparent Triboelectric Nanogenerator Based on Silver Nanowires.....N/A

Jinxin Zhang, Ma-Yue Shi, Xiaoliang Cheng, Yu Song, Haixia Zhang
Peking University, China

This paper reports a novel ultra-thin, stretchable and transparent triboelectric nanogenerator (TENG) based on silver nanowires electrode. The device could not only be used on almost all of the objects surface, including our skins, but also work under kinds of different force, such as compressive force and stretching force. Harvesting mechanical energy based on triboelectrification and electrostatic induction, the TENG achieves maximum output power density about 58.32 μW/cm^2. The device also could work as a self-powered body motion and touch sensor. To assemble the TENG, we first fabricate the stretchable transparent electrode based on silver nanowires. The relative resistance (R/R0) elongation response of the electrode is greatly linear.

Keywords - Triboelectric Nanogenerator, Stretchable, Transparent, Silver Nanowires

Paper ID : C2L-B-2 (#1042)

Backside Nanotexturing Protected by Thin Silicon Layer for High Bending Strength ICs.....569

Chia-Liang Hsu{1}, Kunal Kashyap{1}, Amarendra Kumar{1}, J. Andrew Yeh{1}, Max T. Hou{2}
{1}National Tsing Hua University, Taiwan; {2}National United University, Taiwan

Backside nanotexturing fabricated by electroless metal assisted wet chemical etching, protected with a deposited thin silicon layer, is a new approach to create high bending strength silicon samples. Bending strength for protected nanohole samples followed by CMP process was enhanced by ~3.4 folds as compared to polished silicon samples, which emphasize the dependence of bending strength on nanoholes morphology. The thin protection layer upon nanoholes prevents the unwanted particle trapping, which affects the electrical performances of the device. Dynamic fracture analysis based on fragmentation phenomena, confirmed the improved strength for protecting nanohole samples. Moreover, this technology provides a rupture resistive solution for IC, MEMS and photovoltaic devices for industrial implementation.

Keywords - Nanofabrication, Nanotextures, Silicon ICs, Bending Strength, Stress

Paper ID : C2L-B-3 (#1264) Withdraw

Paper ID : C2L-B-4 (#1182)

Wafer-Level Vacuum Packaging for Hetero-Integration by Thermo-Compression Bonding Using Planarized-Electroplated Gold Bumps.....573

Muhammad Salman Al Farisi, Hideki Hirano, Shuji Tanaka
Tohoku University, Japan

Wafer-level vacuum sealing and electrical interconnection are often crucial for advanced device packaging. This article presents a novel packaging and integration technology, which is applicable to non-planar (i.e. microstructured) and/or temperature-sensitive wafers, by means of Au-Au low-temperature thermo-compression bonding utilizing electroplated Au microbump that surface has been planarized by single-point diamond fly-cut. Device integration, vacuum encapsulation, and electrical interconnection at the same time is the major advantage offered by the proposed technology. In this study, the sealing pressure was evaluated under various bonding conditions by the zero-balance method utilizing diaphragm-structured devices for bonding test. The vacuum sealing pressure was obtained as a few kPa, or even better without introducing any getter materials. The bonding shear strength was also measured to be higher than 100 MPa.

Keywords - Hetero-integration, wafer-level hermetic sealing, Au-Au thermo-compression bonding, single-point diamond fly-cutting, zero-balance method

Paper ID : C2L-B-5 (#1188)

Fabrication of Through Silicon via with Highly Phosphorus-Doped Polycrystalline Si Plugs for Driving an Active-Matrix Nanocrystalline Si Electron Emitter Array.....578

Naokatsu Ikegami{1}, Takashi Yoshida{1}, Akira Kojima{1}, Hiroshi Miyaguchi{1}, Masanori Muroyama{1}, Shinya Yoshida{1}, Kentaro Totsu{1}, Nobuyoshi Koshida{2}, Masayoshi Esashi{1}
{1}Tohoku University, Japan; {2}Tokyo University of Agriculture and Technology, Japan

Present advanced-process for the fabrication of through silicon via (TSV) with highly phosphorus-doped n++- polycrystalline Si plugs for driving an active-matrix nanocrystalline Si (nc-Si) electron emitter array was described. The resistance per one TSV was measured to be 150 Ω, and voltage drop at the TSV plug in a normal driving operation was sufficiently small to apply the diode current to the nc-Si layer. Electrons could be effectively injected into the nc-Si layer from the back-side n++-poly-Si through the TSV plugs, and were quasi-ballistically emitted through the surface Ti/Au electrode.

Keywords - Through Silicon Via, Nanocrystalline Si, Electron Emitter Array, Polycrystalline Si Plug, Phosphorus

C2L-C
MEMS with moleculer sensor
11:10 AM - 12:35 PM, April 20, 2016 Room C (HAGI, 1F)
Zhuqing Wang, Tohoku University (Chair)

Paper ID : C2L-C-1 (#1128)

INVITED TALK
Enhancements of Biosensor's Sensitivity.....N/A
Congo Tak Shing Ching
National Chi Nan University, Taiwan
In the past 20 years, many researches focused on the development of biosensors in order to make them act as a tool for analysis. For example, biosensor is widely used nowadays in clinical diagnosis, environmental monitoring, food safety surveillance and so forth. And, many researches focused on the enhancement of the biosensor's sensitivity. In fact, there are so many approaches to enhance the biosensor's sensitivity, such as by the use of electron-transfer mediators, bimetallic materials, bienzymes, nanowire and etc. In this presentation, the use of sensor array and microfluidic & interdigitated microelectrode on the enhancements of biosensor's sensitivity will be presented.
Keywords - Biosensor, Sensitivity, Signal-to-Noise Ratio

Paper ID : C2L-C-2 (#1139)

Dual-Aptamer Assay for C-Reactive Protein Detection by Using Field-Effect Transistors on an Integrated Microfluidic System.....583
Wei-Chieh Kao, Chia-Ho Chu, Wen-Hsin Chang, Yu-Lin Wang, Gwo-Bin Lee
National Tsing Hua University, Taiwan
Rapid diagnosis of C-reactive protein (CRP) is crucial for preventing cardiovascular diseases because it is a well-known biomarker of cardiovascular diseases. This study presents a dual-aptamer assay for detection of CRP, which is a critical indicator for cardiovascular diseases, by using field-effect transistors (FET). This is the first time that two aptamers, were used to form a sandwich assay such that the CRP concentration could be detected by FET. In addition to electric signals from the FET device, fluorescent signals were also used to confirm this assay. Experimental results revealed that the first aptamer (1st aptamer) and the second aptamer (2nd aptamer) could be specifically binded with target CRP. Furthermore, the microfluidic chip integrated with FET can be reused if the binded CRP and 2nd aptamer was eluted. Besides, in order to prevent the interference material like protein, cells and any nonspecific molecules from adhering onto the gate region of the FET device even after immobilization of 1st aptamer, we used the blocking agent named ethanolamine to prevent nonspecific adhesion, and the results confirmed that blocking using ethanolamine has a good congruence.
Keywords - C-reactive protein, AlGaN HEMT-based FET, dual-aptamer, sandwich assay, ethanolamine, microfluidic

Paper ID : C2L-C-3 (#1157)

Miniaturized Electrochemical Sensor Modified with Aptamers for Rapid Norovirus Detection.....587
Nan Wang{2}, Masaaki Kitajima{3}, Kalaivani Mani{3}, Elgar Kanhere{2}, Andrew Whittle{1}, Michael Triantafyllou{1}, Jianmin Miao{2}
{1}Massachusetts Institute of Technology, United States; {2}Nanyang Technological University, Singapore; {3}Singapore-MIT Alliance for Research and Technology, Singapore
This paper presents a miniaturized electrochemical sensor fabricated by means of MEMS (microelectromechanical systems) techniques, which utilizes aptamers as recognition elements for simple, sensitive and rapid detection of murine norovirus (MNV). The novelty of this work is to integrate micro fabrication technology with aptamers to develop miniaturized and portable electrochemical sensors for environmental monitoring of microbial pathogen. The binding capability between aptamers and on-

chip sensing electrodes is investigated and the performance of proposed MEMS electrochemical aptasensor in terms of sensor responses to different titers of MNVs is characterized.

Keywords - MEMS Electrochemical Sensor, Miniaturized Aptasensor, Murine Norovirus Detection

Paper ID : C2L-C-4 (#1245)

An Array of Micropatterned SU-8 Cantilevers for Drug-Screening Applications.....N/A

Jong Yun Kim, Dong-Weon Lee
Chonnam National University, Korea, South

This paper describe the utilization of microgrooves-integrated SU-8 cantilever arrays for biosensors which analyze the changes of the contraction force and beating frequency of cardiomyocytes in real time in an in vitro environment. The surface- patterned SU-8 cantilevers were manufactured using a conventional photolithography. The longitudinally patterned- microgrooves enhanced the contraction force of cardiomyocytes by 2.7 times, which was due to the alignment of cardiomyocytes on the Su-8 cantilever. The displacement of the SU-8 cantilever by contraction of cardiomyocytes was maximized around day 8. After the preliminary experiments, Isoproterenol and Verapamil were used to understand the physiology of cardiomyocytes regarding drug toxicity. The contraction force was 30% and beating frequency was increased 200% faster for 1microM Isoproterenol and respectively decreased 56% and 42% slower for 500nM Verapamil. The proposed SU-8 cantilever arrays with a laser vibrometer based measurement systems can be expected to the novel drug toxicity screening system in future.

Keywords - Cardiomyocytes, SU-8 cantilever, Laser vibrometer, Contraction force, Drug screening

Paper ID : C2L-C-5 (#1057)

An Integrated Microfluidic System for Antibiotic Resistance Gene Identification Capable Differentiating Live and Dead of Vancomycinresistant Enterococcus.....591

Wen-Hsin Chang{4}, Sung-Yi Yang{1}, Yi-Cheng Lin{1}, Chih-Hung Wang{4}, Huey-Ling You{2}, Jiunn-Jong Wu{3}, Mel S. Lee{2}, Gwo-Bin Lee{4}
{1}Jabil Circuit Inc., Ltd., Taiwan; {2}Kaohsiung Chang Gung Memorial Hospital, Taiwan; {3}National Cheng Kung University / National Yang-Ming University, Taiwan; {4}National Tsing Hua University, Taiwan

This study presents an integrated microfluidic system which can identify vancomycin resistant gene (VanA) from live hetero-bacteria automatically. In this study, a new approach to diagnose VanA gene from live hetero-bacteria by using ethidium monoazide (EMA) and loop-mediated isothermal amplification (LAMP) was proposed and its feasibility was tested and verified. In addition, an integrated microfluidic system including a microfluidic chip and a control system was also demonstrated. The experimental results showed that the proposed system can detect VanA gene from live Enterococcus successfully with a detection limit of 10 colony formation units (CFU) within 1 hour including sample pre-treatment process. This is the first time that an integrated microfluidic system was demonstrated to diagnose VanA gene from live bacteria by LAMP. With its high sensitivity, the proposed system might be promising to verify antibiotic resistance genes from live hetero-bacteria which cannot be achieved by using the existing diagnostic methods.

Keywords - vancomycin resistant gene, microfluidics, live hetero-bacteria,loop-mediated isothermal amplification

C2L-D
Nanocarbon based Devices and Systems 2
11:10 AM - 12:10 PM, April 20, 2016 Room D (TOKIWA, B1F)
Masaki Tanemura, Nagoya Institute of Technology (Chair)
Seiki Akita, Osaka Prefecture University (Co-Chair)

Paper ID : C2L-D-1 (#1034)

Carbon Nanotubes Based Electronic Skins for Wearable Smart System.....N/A
Hui Luo, Wenxiu Yu, Yang Gu, Ting Zhang
Suzhou Institute of Nano-Tech and Nano-Bionics / Chinese Academy of Sciences, China
Flexible electronics are an exciting frontier for the next generation of wearable and portable devices. Flexible sensors have attracted increasing massive attention due to their unique advantages in potential applications of health monitoring. Monitoring body physiological signals including blood pressure, heart rate, and wrist pulse, presents one of the most convenient methods for non-intrusive diagnosis of diseases. Herein we present our recent works on the design and fabrication of flexible capacitive electronic skins based on SWNTs thin films and polystyrene (PS) microspheres, and furthermore we demonstrated their applications as the wearable devices in monitoring pressure signals, which provides a suitable method for real-time health assessment.
Keywords - sensor, flexible, carbon nanotube, polystyrene microspheres, capacitive

Paper ID : C2L-D-2 (#1082)

A Autonomous, Wireless Carbon Nanotube Strain Sensor Embedded in Concrete from Crack Monitoring.....N/A
Fulvio Michelis{3}, Laurence Bodelot{1}, J.-M. Laheurte{2}, Fadi Zaki{3}, Yvan Bonnassieux{1}, Bérengère Lebental{3}
{1}Université Paris Saclay, France; {2}Université Paris-Est, France; {3}Université Paris-Est / Université Paris Saclay, France
We describe the prototyping of a battery-powered, RFID-enabled carbon nanotube strain sensor for concrete strain and crack monitoring. A series of 10 prototypes has been embedded in a real structure. After a year it is still providing valuable information on the state of the structure. The final volume of the embedded module is 43cm^3, the lowest volume reported to date in the field of embedded monitoring of concrete.
Keywords - ccarbon nanotube strain sensor, system integration, deployment, structural health monitoring

Paper ID : C2L-D-3 (#1276)

Wafer-Level Technology for Integration of Carbon Nanotubes Into Micro-Electro-Mechanical Systems.....595
Jens Bonitz{2}, Simon Böttger{2}, Sascha Herrmann{2}, Stefan Schulz{1}, Thomas Gessner{1}, Steffen Hartmann{2}, Bernhard Wunderle{2}
{1}Fraunhofer Institute for Electronic Nano Systems ENAS, Germany; {2}Technische Universität Chemnitz, Germany
In this paper we present a holistic wafer-level manufacturing process for nanoscopic sensor devices based on individualized single-wall carbon nanotubes (SWCNTs) integrated in MEMS. The fabrication technology is demonstrated in detail. Moreover, a first application in form of a MEMS test stage for SWCNT strain and reliability experiments is shown.
Keywords - Carbon Nanotubes, Integration Technology, Nanosensors, in situ TEM

Paper ID : C2L-D-4 (#1175)

Fabrication and Characterization of CNT Forest Integrated Micromechanical Resonator for Rarefied Gas Sensor.....N/A

Koji Sugano{1}, Ryu Matsumoto{1}, Ryota Tsutsui{1}, Hiroyuki Kishihara{1}, Naoki Matsuzuka{2}, Yoshitada Isono{1}
{1}Kobe University, Japan; {2}National Institute of Technology, Akashi College, Japan

This study developed the multi-walled carbon nanotubes (CNTs) forest integrated micromechanical resonator working as a rarefied gas sensor for nitrogen (N_2) and hydrogen (H_2) gases. The resonant response is detected depending on the gas species and the gas pressure as changes of the resonance frequency and damping effects. The CNT forest on the resonator enhances the effective specific surface area of the resonator so that the damping effect significantly increases. We developed the fabrication process for the proposed resonator, which consists of the MEMS process and high density CNT synthesis on the resonator mass using ferritin proteins coating as a catalytic iron particle. Two devices with deferent CNT densities were fabricated and characterized to evaluate an effect of CNT density on resonant response. We found that the higher density device was able to distinguish N_2 and H_2 gases clearly under 1 Pa. These results were explained from the kinetic theory of gases.

Keywords - CNT, micromechanical resonator, gas sensor

C2L-E

Nanophotonics/Microoptics 3

11:10 AM - 12:15 PM, April 20, 2016 Room E (SUEHIRO, B1F)

Junichi Takahara, Osaka University (Chair)

Paper ID : C2L-E-1 (#1105)

INVITED TALK

Continuous Wave Terahertz Signal Generator Based on Difference Frequency Generation in Gallium Phosphide Crystal and its Applications for Spectroscopy.....600

Tetsuo Sasaki{2}, Tadao Tanabe{3}, Tomoaki Sakamoto{1}, Jun-Ichi Nishizawa{3}
{1}National Institute of Health Sciences, Japan; {2}Shizuoka University, Japan; {3}Tohoku University, Japan

We developed a wide frequency tunable Continuous Wave (CW) Terahertz (THz) Signal Generator (SG) on the principle of Difference Frequency Generation (DFG) in a Gallium Phosphide (GaP) crystal. The CW THz SG has the merits of high resolution, high accuracy, wide dynamic range, high stability, high durability, easy operation/maintenance, and low cost. Combining the CW THz SG as a light source with a superconducting Transition Edge Sendsor (TES) bolometer cooled by a pulse tube refrigerator, the spectrometer working as a non-stop system could be realized. As we could have increased the THz output power up to 0.1 μW at the sacrifice of lack of frequency resolution, it is now possible to apply pyroelectric detectors and a bolometer camera at room temperature operation for spectrometer or monochromatic imaging. Accurate THz spectromer could be used for evaluation of orgainic crystals like as pharmaceuticals. One of the reasons for underutilization of THz spectroscopy till now is that most of the absorptions observed in THz range in organic materials are not assigned to vibrational modes. We have developed a technique to clarify them by comparing polarization dependent spectra of pharmaceutical single crystals with Density Function Theory (DFT) calculation results.

Keywords - Terahertz Signal Generator, Spectroscopy, Pharmaceuticals

Paper ID : C2L-E-2 (#1187)

INVITED TALK

Near-Field Circular Dichroism Imaging to Design Optically Active Nanomaterials.....N/A

Tetsuya Narushima, Shun Hashiyada, Hiromi Okamoto
Institute for Molecular Science / Chinese Academy of Sciences, Japan

Nanostructures composed with chiral shapes behave like chiral molecules and show optical activity as typified by optical rotation or circular dichroism (CD). To design the sample shapes to realize desired optical activity and evaluate them, information on local optical responses in the nanostructured sample, including optical activity, is indispensable. For this purpose, we combined an aperture-type near-field optical microscope with a CD detection system. The near-field CD microscope can visualize local CD distribution in individual nanostructures, which can be also compared with the macroscopically obtained CD spectra. Local CD signals of both handednesses coexisted in the individual nanostructures, and the spatial distribution of the CD reflected the geometrical symmetry of the nanostructure. The local CD signals were two orders of magnitude larger than the macroscopic CD signal. It is highly probable that strongly twisted optical fields were generated where the locally pronounced CD was observed, which may provide potential applications in chiral chemistry and biosciences.

Keywords - Chirality, Circular Dichroism, Optical Activity, Optical Near-Field

Paper ID : C2L-E-3 (#1084)

All-Optical Modulation in the Hybrid Si/GaN Microring Resonator by Electro-Absorptive Resonance Detuning.....N/A

Borriboon Thubthimthong, Takashi Sasaki, Kazuhiro Hane
Tohoku University, Japan

We investigated all-optical modulation in a hybrid Si/GaN microring resonator operating at a telecommunication wavelength of around 1560 nm. To prevent modulating signals at the GaN microring leaking into the Si bus waveguide circuit, we used a 325-nm laser (photon energy = 3.8 eV) for the modulating signal and pumped them onto the GaN microring (band gap = 3.4 eV). This resulted in temperature rise and refractive index change due to electro-absorption, causing the resonance of the system to be altered. We fabricated and tested the device and found the maximum modulation depth of 0.83 and the modulation bandwidth of more than 10 kHz. Such simple nanophotonic structure with a small footprint might benefit, thank to free-space out-of-plane optical control, dense all-optical routing, switching, modulation in the future lightwave computing.

Keywords - All-optical Modulation, Hybrid Si/III-V Platform, Silicon Nanophotonics, Gallium Nitride, Microring Resonator, Resonance Detuning, Nanofabrication

C2L-F
Micro/Nanomechanics and instrumentation 2

11:10 AM - 12:35 PM, April 20, 2016 Room B1 (CHIYO 1, 1F)

Jun Dai, Beijing Institute of Technology (Chair)

Paper ID : C2L-F-1 (#1263)

INVITED TALK

Dual-AFM Probes as an Imaging and in-situ Molecular Operation Tool.....N/A

Takashi Mineta
Yamagata University, Japan

This paper reviews the dual-AFM probes with functions of imaging and in-situ molecular operations such as mechanical cutting and delivery of bio-molecules. Fabrication techniques based on self-align Si etching process enabled us to make triangular-pyramidal-shaped twin AFM tips with a narrow gap less than 1 μm, which minimize the offset calibration while switching from one probe to another. Orthogonally located dual Si cantilever with a magneto-strictive FePd alloy film has also been developed for switching the probes by application of external magnetic flux. In many alloys, magneto-striction tends to drastically decrease when they are thin films. In contrast, the FePd alloy film showed large magnet-striction above 200 ppm even though it was thin

film with a thickness of 1 μm. Moreover, fabrication technique of a hollow Si cantilever with a micro channel and outlet hole has developed to combine with the dual cantilever structure. The hollow dual AFM prove will provide a novel function of in-situ molecular delivery. We anticipate the new multi-functional AFM probes to contribute in fundamental studies on bio- molecular science and technologies.

Keywords - Dual AFM prpbe, Dual cantilever, magneto-strictive film, Narrow-gapped tip

Paper ID : C2L-F-2 (#1329)

Characterization of a Micro Thermal Sensor for Surface Defect Inspection.....N/A

Yuki Shimizu, Yuki Matsuno, Yuta Ohba, Yuan-Liu Chen, Wei Gao
Tohoku University, Japan

This paper presents an experimental study on a characterization of a micro thermal sensor for a defect inspection on a nanometric smooth surface. In the proposed concept of the surface defect inspection, the micro thermal sensor is utilized to find out surface defects by detecting variation of the heat balance at the gap between the sensor surface and a smoothly-finished surface. Experimental results in previous work have revealed that the thermal sensor has a capability of detecting a rate of heat supply of 10 microwatt. In this paper, efforts are made to focus on asperity-type surface defect detection. An experimental setup employing a self-detective atomic force microscope (AFM) probe with is developed to investigate the feasibility of the thermal sensor for detecting asperity-type small defects with a size of several-ten nm. By employing the AFM probe having a tip radius of 20 nm, a collision between the sensor surface and a defect with a size on the order of several tens of nm can be simulated, while the position of a collision point is verified. Some experiments are carried out to demonstrate the feasibility of the thermal sensor.

Keywords - thermal sensor, defect inspection, heat balance, atomic force microscope

Paper ID : C2L-F-3 (#1257)

In-Situ Cellular-Scale Injection for Alive Plants by Micro-Bubble Injector.....604

Sohei Itabashi{1}, Takuya Kambayashi{1}, Takatoshi Shimamura{1}, Kazuki Takahashi{1}, Yoko Yamanishi{2}
{1}Shibaura Institute of Technology, Japan; {2}Shibaura Institute of Technology / Japan Science and Technology Agency, Japan

We have achieved local and in situ injection of reagent into a single plant cell by using the cavitation phenomenon of micro-bubbles. Micro-bubbles were generated electrically by a novel device called ”micro-bubble injector” which provide minimally invasive process and high accessibility compared to conventional injection techniques.

Keywords - Gene transfer, micro-bubbles, Plant cell

Paper ID : C2L-F-4 (#1342)

Compliant MEMS Structure for Observation of Fixed Point Under Tensile Deformation.....N/A

Taeko Ando{2}, Kohei Ueno{2}, Masahiro Nakajima{1}
{1}Nagoya University, Japan; {2}Ritsumeikan University, Japan

This study reports on a novel concept of tensile testing in TEM with MEMS structure for high-resolution observation at a fixed point under tensile deformation. The device design is based on a compliant mechanism with deformable frame and rigid beams with flexure hinges to achieve design requirements. External load applied to the device by PZT actuator is transformed into tensile force to the specimen in both directions by virtue of the compliant mechanism. We demonstrated the tensile test of single crystal silicon specimen with thickness of several nanometers on TEM holder using in-situ SEM observation.

Keywords - Tensile test, TEM, compliant mechanism

Paper ID : C2L-F-5 (#1197)

Development of MEMS Electrostatic Condenser Lens Array of the Massive Parallel Electron Beam Direct-Write System.....N/A

Akira Kojima{1}, Naokatsu Ikegami{1}, Takashi Yoshida{1}, Hiroshi Miyaguchi{1}, Shinya Yoshida{1}, Masanori Muroyama{1}, Kentaro Totsu{1}, Masayoshi Esashi{1}, Nobuyoshi Koshida{2}
{1}Tohoku University, Japan; {2}Tokyo University of Agriculture and Technology, Japan

In this paper, a development of MEMS electrostatic condenser lens array for the massive parallel electron beam direct-write system (MPEBDW) is presented. The condenser lens converges electron beam emitted from a nanocrystalline silicon (nc-Si) ballistic electron emitter as an electron source of MPEBDW for high resolution patterning. The lens is designed and analyzed by a finite element method (FEM) simulation with a consideration of self-inconsistency electric field. The condenser lens array was fabricated with precise machining methods. The simulation results showed that the proposed structure can focus the beams with size of less than 1/10 of the emitted beams. As a result of conducting the electron beam convergence experiment by the condenser lens array and projecting the beams on the fluorescent screen, the almost same behavior as the simulation was confirmed.

Keywords - massive parallel, electron beam lithography, condenser lens array, electron optics, nanocrystalline sil

A4P-B
Poster session 1
5:15 PM - 7:05 PM Room B1-2 (CHIYO 1-2, 1F)

Paper ID : A4P-B-1 (#1086)
Microcantilever Metamaterial for Advanced Control of Near-Field Coupled Meta-Atoms Operating in Terahertz Spectral Region.....N/A
Prakash Pitchappa{2}, Manukumara Manjappa{1}, Chong Pei Ho{2}, Dihan Hasan{2}, Ranjan Singh{1}, Chengkuo Lee{2}
{1}Nanyang Technological University, Singapore; {2}National University of Singapore, Singapore
We report a microcantilever metamaterial with independently reconfigurable near-field coupled bright and dark mode resonators for advanced manipulation of electromagnetically induced transparency (EIT) analogue in the terahertz spectral region. The selective tuning of bright mode resonance results in modulation of EIT intensity, while the selective tuning of dark mode resonance achieves spectral shift in EIT peak. Furthermore, simultaneous reconfiguration of bright and dark resonances allows for dynamic switching of coupling state between strongly coupled and uncoupled states. The active control of EIT analogue also enables modulation and spectral tuning of slow light behavior of the metamaterial. Interestingly, the proposed microcantilever based independent reconfiguration of the coupled mode resonators can be readily extended to other class of coupled systems such as inductively, capacitively and conductively coupled resonators either in-plane or out-of-plane directions
Keywords - MEMS metamaterial, coupled resonators, active control

Paper ID : A4P-B-2 (#1216)
Photocurrent Optimize of InAs/GaAs p-i-p Quantum Dots Infrared Photodetectors.....148
B. Zhang, H. D. Lu, W. G. Ning, F. M. Guo
East China Normal University, China
The InAs/GaAs p-i-p quantum dots infrared photodetectors (QDIPs) were detailedly demonstrated by Apsys software in the paper. The device consists of $Al_{0.3}Ga_{0.7}As$/GaAs supper lattice (SL) and InAs quantum dots (QDs) embedded in In0.15Ga0.85As, which make device has an advantages of low dark current and large photocurrent at room temperature (300K). The dark current and photocurrent of the device with different InAs QDs density and the number of $Al_{0.3}Ga_{0.7}As$/GaAs SL is discussed detailedly.
Keywords - InAs quantum dots, infrared photodetectors, quantum dots density, super lattice.

Paper ID : A4P-B-3 (#1217)
The Simulation of Resonant Tunneling Devices Containing InAs Quantum Dots.....160
J Song, W. G. Ning, H. D. Lu, F. M. Guo
East China Normal University, China
A resonant tunneling devices (RTDs) model containing InAs quantum dots (QDs) is discussed in this paper. The current-voltage characteristics of this model at different simulation temperature are investigated. Each I-V curve have two tunneling peak and the tunneling current increasing along with the decline of temperature. To illustrate QDs can capture charges and store charges, two different structures are compared. Peak current of structure without QDs' peak current is larger than structure with QDs. We simulate the photoluminescence (PL) of InAs QDs, and we also compare some methods which can reduce the operating current.
Keywords - InAs QDs, RTD, tunneling current, carrier

Paper ID : A4P-B-4 (#1003)

Well-Aligned ZnO Nanorods Grown Directly on GaN Substrates for Optoelectronic Applications.....176

Roman Yatskiv, Jan Grym
Institute of Photonics and Electronics of the AS CR, v.v.i., Czech Rep.

We report the growth of ZnO nanorods directly on GaN templates. To control the position and size of the ZnO nanorods, the GaN template was patterned by e-beam lithography. The optical properties of the ZnO nanorods were studied by photoluminescence spectroscopy.

Keywords - ZnO nanorods, photoluminescence, e-beam lithography

Paper ID : A4P-B-5 (#1006)

Vibration and Large Deformation Simulation Analysis of Graphene Membrane for Nanomechanical Applications.....209

Ping Li{1}, Rahman Hebibul{2}, Libo Zhao{1}, Zhikang Li{1}, Yulong Zhao{1}, Zhuangde Jiang{1}
{1}Xi'an Jiaotong University, China; {2}Xinjiang Vocational & Technical College of Communications, China

This paper reports an efficient and accurate simulation method for vibration and deformation of single- and multi-layer graphene membranes,which is a very promising material for nanomechanical resonator,like pressure and acoustic sensors.By comparing the numerical methods using two kinds of finite element software ANSYS and COMSOL respectively,we found that the COMSOL software is more suitable and convenient for nanoscale structural analysis.

Keywords - graphene membranes,simulation method,2-D plate element,SHELL element,vibration,nonlinear deformatio

Paper ID : A4P-B-6 (#1012)

In-Situ Integration of Anisotropic SnO_2 Heterostructures Inside Three-Dimensional Graphene Aerogel for Enhanced Lithium Storage.....N/A

Xin Yao{1}, Yang Zhao{1}, Chung Yen Ang{1}, Zhong Luo{1}, Kim Truc Nguyen{2}, Pei-Zhou Li{1}, Yanli Zhao{1}, Guilue Guo{1}, Xing Ma{1}, Qingyu Yan{1}
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A Three-dimensional (3D) graphene aerogel (GA) has emerged as an outstanding support for metal oxides to enhance the overall energy-storage performance of the resulted hybrid materials. In current stage of the studies, metals/metal oxides inside GA are in un-crafted geometries. Introducing structure-controlled metal oxides into GA may further push electrochemical properties of metal oxide-GA hybrids. Using rutile SnO_2 as an instance, we here demonstrated a facile hydrothermal strategy combined with a preconditioning technique named vacuum-assisted impregnation for in-situ construction of controlled anisotropic SnO_2 heterostructures inside GA. The obtained hybrid material was fully characterized in detail, and its formation mechanism was investigated by monitoring the phase-transformation process.

Keywords - Nanomaterials, graphene, lithium ion battery

Paper ID : A4P-B-7 (#1068)

Improving Film Characteristics of Pyrene Derivatized Carbon Nanotubes by 3-Aminopropyltri-Ethoxysilane and N,N'-Diisopropylcarbodiimide Crosslinker.....241

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In this work, we used different pyrenes derivatized with a carboxylic acid group to modify the surface of carbon nanotubes . This non-covalent method of functionalization can improve the dispersion of CNTs in organic solvent without damaging the desired properties of CNTs. Thin films of CNTs functionalized with pyrene derivatives were deposited onto the glass substrate, which in prior, was treated by APTES . DIC, a cross-linker, facilitates the reaction of carboxylic acid group on CNT with the amino group of APTES. We found that the introduction of DIC resulted in increased robustness of CNT thin films on the glass substrate. Increase of interfacial adhesion can be attributed to the covalent bond formed during this process. We studied the effect of concentration of APTES and DIC on film adherence by subjecting them to waterjet. Our results show that the CNT thin films were robust and smooth. The morphology analysis by Scanning Electron Microscopy and Atomic Force Microscopy techniques reveal that the surface functionalized CNT thin films on glass substrates were smooth and the roughness was about 21.3 nm for the APTES-treated sample.

Keywords - Pyrene, Carbon Nanotubes, APTES, silane, functionlization.

Paper ID : A4P-B-8 (#1110)

Rapid, Low-Temperature Fabrication of Co_3O_4 Nanorods for High Performance Microsupercapacitors.....N/A

Shuxuan Feng, Xinyu Ma, Zehua Liu, Hangfu Zeng, Yunfei Wang, Ruiqi Zhu, Ding Wang, Liang He, Liqiang Mai
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A microsupercapacitor based on separated interdigital electrodes consisting of Co_3O_4 nanorods by a rapid, low-temperature fabrication method has been investigated in this research. By utilizing the microfabrication process including photolithography, lift-off, and rapid thermal annealing (RTA), the microsupercapacitor with reproducible shape and dimensions on a large scale can be fabricated. Also, the characterizations of the Co_3O_4 nanorods and the specific capacity of the microsupercapacitor were presented. The resulting supercapacitor with the Cr/Au current collector has a capacity of 28.8 F/cm^3 at the scan rate of 0.01 V/s.

Keywords - Cobalt Oxide, Nanorods, Supercapacitors, Rapid Thermal Annealing, Photolithography

Paper ID : A4P-B-9 (#1156)

A ZnO Nanowire Ultraviolet Photodetector Fabricated by Dielectrophoresis Technique.....N/A

Lei Li, Weixuan Jing, Zhuangde Jiang, Shuming Yang, Chenying Wang, Feng Han, Qijing Lin, Ping Yang
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We presented an ultraviolet (UV) photodetector constructed with ZnO nanowire. The ZnO nanowire was synthesized by chemical vapor deposition (CVD) method. The following characteristic experiment results showed that the ZnO nanowire were about 100nm to 300nm, the length was tens of micrometer, the ZnO nanowire presented obvious UV photoluminescence centered at 385 nm. Alternative current dielectrophoresis technique was used to assemble the ZnO nanowire photodetector. I-V and photoresponse experiments indicated that the device was an back-to-back Schottky diode characteristic, which was because of the Schottky contact between ZnO nanowire and Au electrode. The photoresponsivity of the device was as high as 4583 A/W and the raise and decay time was 0.1 s and 0.2 s, respectively.

Keywords - ZnO nanowire, CVD, photodetector, dielectrophoresis, Schottky contact

Paper ID : A4P-B-10 (#1180)

Characterization of Electret Made of Mixture Contains Mesoporous Silica Nanoparticles and Fluorocarbon Polymer.....N/A

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A novel electret based on inorganic-organic nano composite using fluoropolymer and mesoporous-silica nanoparticles was developed in this study. CYTOP® is used to fabricate the nanocomposite electret, which is one of fluoropolymer. The nanoparticles were mixed in the CYTOP, followed by negative charge implantation into the composite materials. The initial surface potential of the nanocomposite electret was higher than that of a control electret made of pure CYTOP. Additionally, time stability of those was also better than that of control electret.

Keywords - Electret, Nanocomposite, Mesiporous Silica

Paper ID : A4P-B-11 (#1190)

Operando Spectromicroscopy on Graphene Transistors to Bridge Material-Device Gap.....N/A

Hirokazu Fukidome{2}, Ryo Sato{2}, Kosuke Nagashio{3}, Masato Kotsugi{1}, Takuo Ohkochi{1}, Toyohiko Kinoshita{1}, Akira Toriumi{3}, Maki Suemitsu{2}
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Graphene, the 2D honeycomb of sp2-bonded carbon atoms, has the highest carrier mobility and saturation velocity because of a linear band dispersion. Graphene is therefore promising as the next-generation device materials. However, graphene devices, such as graphene field-effect transistor (GFET), do not exhibit high performances as anticipated from its intrinsic electronic properties. Here we demonstrate operando spectromicroscopy, i.e. nanoscopic soft x-ray absorption spectroscopy under operation conditions, on GFET to elucidate modulation of electronic states by interface, which brings about parasitic resistance, e.g. contact resistances. The modulation is inferred from the change in many-body effects in the x-ray absorption processes, which depends on density of states near the Fermi level.

Keywords - graphene, operando, spectromicroscopy

Paper ID : A4P-B-12 (#1223)

Formation of Particular Graphene Structures Through H2 Induced Anisotropic Etching.....N/A

Rémi Papon, Subash Sharma, Sachin Maruti Shinde, Amutha Thangaraja, Golap Kalita, Masaki Tanemura
Nagoya Institute of Technology, Japan

Graphene is a zero band gap two dimensional (2D) material which could have an open band gap through H_2 anisotropic etching and fabricated controlled structures. Two kinds of crystals are observed, one regular and one dendritic, which lead to different etching patterns, the former with holes and the latter with fractal structures.

Keywords - CVD, graphene, hydrogen, anisotropic etching, band gap

Paper ID : A4P-B-13 (#1015) Withdraw

Paper ID : A4P-B-14 (#1241)

Enriched Semiconducting Single Wall Nanotubes as Back Contact for CdTe Solar Cell.....107

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For CdS/CdTe solar cells with conventional Cu doped CdTe at the back contact, the diffusion of copper into CdS window layer would damage the heterojunction and deteriorate the device performance. In order to obviate this problem, we fabricated single wall carbon nanotube thin films with 95% semiconducting ratio (95% S-SWNT) via spin-coating method, and applied it as the back contact of CdS/CdTe device. Owing to the excellent electrical properties of SWNT thin film, we achieved 9.71% power conversion efficiency device with S-SWNT/Au back contact.

Keywords - CdS/CdTe device, back contact, S-SWNT, spin-coating

Paper ID : A4P-B-15 (#1021)

CNT Handling with van der Waals Force Inside a SEM for FET Application.....111

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This paper presented a method of picking up carbon nanotubes (CNTs) from nanotube bulk by van der Waals force between the carbon nanotubes and AFM cantilever under scanning electron microscopy (SEM). A manipulation strategy was established based on SEM by analyzing the van der Waals force of three different types of contacting model. Three groups of experiments were designed and carried out to investigate the effects of different factors which conclude pickup angle, pickup contact area between the carbon nanotube and the cantilever and pickup speed of the end-effector. The results shown that a pickup angle at 90.1ºand a pickup speed at 10nm/step with a pickup contact length more than 1.5 μm would increasing the probability of picking up CNT successfully

Keywords - CNT, Nanomanipulation, van der Waals Force

Paper ID : A4P-B-16 (#1299)

Process Optimization for Single Molecular Recognition Using AFM Based Nanorobot.....N/A

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Understanding single molecular interactions shines light on various fundamental and application researches, such as receptor-ligand interactions and drug discovery. AFM is a powerful tool to measure single molecular interactions. AFM can measure the single molecular interactions with pico-newton resolution. Besides this, AFM has also been augmented into nanorobot to facilitate automation in nanoscale. With previous advances, the measurement setting has been well established and widely used. However, the signal/noise ratio of the data are quite low: only ~10 to 15 % of the data points contains the single molecular interactions information. This weakens the credibility of the measurement. Here, we aims to improve the signal to noise ratio through optimizing the parameters during the measurement. We evaluated the effects of several parameters: moving speed of AFM tip, interaction time, and indentation level. Via these advances, we expect to raise the signal to noise ratio dramatically. Combining these advances with the AFM based nanorobot, the automated measurement of single molecular interaction emerges for many applications.

Keywords - AFM, nanorobot, single molecular interaction,

Paper ID : A4P-B-17 (#1313)

Measurement of Output Current for Ferroelectric Micro-Plasma Thruster.....117

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A charge collector based on capacitor charging principle is proposed to measure the ion current from the nozzle of the ferroelectric micro-plasma thruster(FMPT). The relationship between nozzle diameters, applied voltage and output current of FMPT were tested and discussed.

Keywords - ferroelectric micro-plasma thruster, charge collector, output curre

Paper ID: A4P-B-18 (#1050)

The Implementation of Silver Mirror Reaction for the Quality Improvement of Low Temperature Inkjet Printing Microfabrication: the First Printed Metal Oxide Based Flexible pH Sensor.....N/A

Jia-Chyi Pan, Zi-Li Guo, Yu-Ting Cheng
National Chiao Tung University, Taiwan

The abstract presents a method to improve the inkjet printing quality at low process temperature, i.e. <100°C, for low cost flexible microsystem fabrication via the implementation of Ag mirror-reaction. The reactive process can not only reduce electrical resistivity of the printed Ag interconnects but also strengthen printed microstructures for sensor fabrication like the pH meter to be demonstrated. After with the reaction, the resistivity of a printed Ag line can be reduced to 7.7 uΩ· cm, which is lower than the state of the art realized by 150°C thermally sintering [1]. Meanwhile, a WO_3 based flexible pH sensor is firstly printed with a sensitivity of -54.7mV/pH, which is comparable with the device performance of conventional thin film pH sensors.

Keywords - pH sensor,WO_3,low temperature

Paper ID : A4P-B-19 (#1053)

An Experimental and Analytical Method to Observe the Polysilicon Nanowire MOSFET Threshold Voltage.....121

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A new double integration-based method to extract model parameters is applied to experimental polysilicon nanowire MOSFETs. It was experimentally found that the saturation current shows the sensitivity of the Nano-wire MOSFETs if the conventional method fails to show the sensitivity depending upon the threshold voltage of Nano-wire MOSFET. It shows that the present method offers advantage over previous extraction procedure which use trans-conductance curve in the saturation mode, and the threshold voltage is determined by the intercept of curve. In addition to show how compact model for the Id-Vg characteristics are numerically evaluated and examined. The drain and gate bias dependencies of device current are shown. Also the model we proposed fits to the silicon data. Our experimental results support the model which we proposed in this paper. The drain current measured in saturation region can easily show the change in current level at different conditions but the convention theory for the linear region is difficult to do for sensitivity test of Nano-wire.

Keywords - nanowire, undoped-polysilicon,native gate oxide, mean-free path.

Paper ID : A4P-B-20 (#1009)

Fabrication of Glass Mold Using Nd:YVO_4 Laser for Capillary Filling of Plasma in Microfluidic Channel.....N/A

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In this study, we proposed a simple and repeatable method for fabricating microfluidic channels. Since it is a maskless method, it is relatively inexpensive and faster than conventional lithography techniques. Moreover, unlike other direct laser processing, the proposed method requires significantly less energy, hence reduce the thermal affect. The capillary filling speed of plasma in hydrophilic microfluidic channels is investigated under various cross-section sizes and temperature conditions. The geometries of the channles: 19.5x2.5, 17.0x1.6, and 7.6x1.1μm^2 (width x height) are fabricated on borosilicate glass substrates using Nd:YVO_4 laser (wavelength of 532 nm) dissolving glass to forming bump structures. Following the laser processing, the glass mold was used to transfer the microchannel to a polydimethylsiloxane (PDMS) layer. Finally, the PDMS structure was aligned with a glass cover plate and sealed using an oxygen plasma treatment process. The capillary filling speed of the plasma is measured experimentally. The results show that the filling speed reduces with a reducing channel cross-section, a lower operating temperature and an increased filling length.

Keywords - Capillary filling, Microchannels, Nd:YVO_4 laser, Plasma, PDMS.

Paper ID : A4P-B-21 (#1020)

Development of an Optically-Induced-Dielectrophoretic (ODEP) Force-Based Microfluidic System for High-Purity Circulating Tumor Cell Isolation.....N/A

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The analysis of specific gene expression of patient's circulating tumor cells (CTCs) holds promise to select a more effective therapeutic regimen for an individual patient. However, the current CTC isolations schemes can not isolate CTCs with high purity for gene expression analysis. To address this issue, we proposed to integrate the technique of optically-induced-dielectrophoretic (ODEP) force-based cell manipulation in a microfluidic system to further purify the CTCs after the conventional CTC isolation process. Results showed that the purity of the CTCs isolated through the proposed method was as high as 100%, which is beyond currently possible using the existing CTC isolation techniques. Overall, this study has developed a device capable of further purifying CTCs after the current CTC isolation methods.

Keywords - Microfluidic technology, Optically-induced-dielectrophoretic, Circulating tumor cells (CTCs), Cancer cells

Paper ID : A4P-B-22 (#1041)

Design and Simulation of a Thermal Flow Sensor for Gravity-Driven Microfluidic Applications.....125

Antti-Juhana Mäki, Anton Kontunen, Tomi Ryynänen, Jarmo Verho, Joose Kreutzer, Jukka Lekkala, Pasi Kallio
Tampere University of Technology, Finland

Gravity-driven flow is an attractive approach to develop simpler microfluidic systems. Because clogged microchannels could easily lead to fatal operational failures, it is crucial to monitor flow rate in these systems. Therefore, we propose here for the first time a numerical model that combines a calorimetric flow sensor and a gravity-driven system. The model allows not only to study the flow behavior, but also to optimize the flow sensor layout for different gravity-driven systems.

Keywords - calorimetric flow sensor, gravity-driven flow, modeling

Paper ID : A4P-B-23 (#1043)

Hydraulic Extraction of High Quality Sperms from a Dual Gradient Sperm Sorter for in-Vitro Fertilizatio.....130

Yueh-Jen Chen{1}, Ren-Guei Wu{1}, Peng-Chun Chen{1}, Yu-Nan Lin{1}, Huei-Wen Hsiu{2}, Ching-Chu Yen{2}, Chia-Woei Wang{2}, Li-Chern Pan{2}, Fan-Gang Tseng{1}
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This paper proposes a selection and extraction strategy to acquire high quality sperms from a biomimetic microfluidic device capable of generating a dual gradient flow field for motile sperm sorting. The sorter consists of a straight flow zone, a rapidly expansion sector for sperm sorting by gradient up-stream flow, and a dumbbell channel for dead sperms separation at the outlet. A collateral runner is set at the front area of the expansion sector, but mostly kept in dry state without affecting the sorting process. At the end of sorting, the outlet was blocked to moisten the collateral runner, and a pressure was applied from the inlet to flush the high quality sperms into the collateral runner for collection. Controllable numbers, ranging from 1 to 5000, of sperms can be collected with a G2 motility (>120μm) ratio higher than 70%, suitable for in-vitro fertilization (IVF).

Keywords - sperms sorting, extraction

Paper ID : A4P-B-24 (#1044)

A Three-Dimensional Microfluidic Device for Oocyte Zona-Removal and Incubation.....134

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To solve the low implantation rate of in-vitro fertilization (IVF), zona-free oocyte is widely used in IVF [1]. However the process of zona-removal is not only tedious but also easy to harm the fragile oocyte. In this work we introduce a 3-dimensional microfluidic device to simplify the zona-removal process, and the applied gentle process is also capable to keep oocyte intact and precisely locate all oocytes in the well throughout the procedure.

Keywords - In-vitro fertilization, Zona-free oocyte, Microfluidic device.

Paper ID : A4P-B-25 (#1193)

Flow-Focusing Microfluidic Devices with Organic Solvent Resistance.....N/A

Ikuko Morita, Yunjung Heo, Yasuhisa Ando
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Controlled-release drug delivery systems (DDS) have been gathering attention since it provides medication over an extended time period. Biodegradable microspheres have been employed as simple, minimally-invasive, injectable DDS. To produce microspheres with high-throughput and high-uniformity, flow-focusing microfluidic devices have been widely used. Most previous devices, however, did not have organic solvent resistance, thus having barriers in immobilizing organic solvent-soluble drugs. We here fabricated a flow-focusing microfluidic device with organic-solvent resistant elastomer. By flowing polymer dissolved in organic solvent in the present devices, we formed microspheres with 67.0±1.6 μm diameter. We envision that the present device can be useful for development of controlled-release DDS for poorly water-soluble drugs.

Keywords - organic solvent resistnace, microscale flows, microsphere formation, drug delivery system

Paper ID : A4P-B-26 (#1343)

Liquid Reagent Storage in Self-Pumping Lab-on-a-Chip Systems for Quick Assay and Biosensor Integration.....139

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{3}Technische Universität Chemnitz, Germany

We present a novel approach for liquid reagent storage in lab-on-a-chip systems. A special normally-closed valving technology using thermal-release adhesive tapes is presented. The cartridge and experimental setup is explained. The thermal release tape is opened by attaching heating elements to the areas to be opened. Heating parameters were optimized and a newly developed cartridge containing nine liquid reservoirs is emptied completely automatically, including valve-opening steps and integrated pumping.

Keywords - lab-on-a-chip, microfluidics, micro pumps, reagent storage, biosensor integration, assay integration

Paper ID : A4P-B-27 (#1230)

Microfluidic Embedded BiCMOS Process for Dielectrophoresis Trapping of Microparticles.....N/A

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This paper presents a microfluidic embedded BiCMOS process for lab-on-chip (LOC) technology using dielectrophoresis (DEP) based single cell manipulation and trapping. The microelectrodes as well as the microfluidic channel have been fabricated in a standard BiCMOS technology by the modification of the back-end-of-line (BEOL) stack of BiCMOS. For an efficient trapping and detection, a thick metallization stack from Metal5 to Metal3 has been used for the microelectrodes. The microchannel has been fabricated by deep reactive ion etching (DRIE) of the oxide in the BEOL. In order to cover the microfluidic channel an optically transparent PDMS polymer layer has been used. The BiCMOS integrated microfluidic platform has been tested using commercial single 15 µm diameter polystyrene beads usually used for cytometer calibration. Single particle trapping has been managed biasing the microelectrodes in the upper kHz and lower MHz range. In this regard, this lab-on-BiCMOS chip integration process opens new opportunities to combine the performance benefits of on-chip sensors with lab-on-chip platforms.

Keywords - microfluidics, single cell, BiCMOS, THz, electomanipulation, biosensing

Paper ID : A4P-B-28 (#1240)

High-Throughput Injection by Circulating Plasma-Bubbles Laden Flows.....144

Keishi Ohtonari{1}, Yuta Arakawa{1}, Hiroki Ogata{1}, Daisuke Tujimoto{1}, Yoko Yamanishi{2}
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Abstract - We have succeeded in injection of plasmid to adherent cells which are suspended in the plasma-bubbles laden circulation flow in a chamber. High-speed plasma-bubbles are generated by glass electrode and the air-liquid interface has a stiction force which draws the gene (plasmid) and stick to the air-liquid interface. The circulating flow increased the chance for cells to contact air-liquid interface of bubbles which enclosed plasma or reactive gas. Finally, the high reactive interface enables gene transfer to cells efficiently. This technology contributes high-throughput gene transfer in two dimensional microfluidic chip.

Keywords - Gene transfer, Plasma-bubbles, Bio-chip

Paper ID : A4P-B-29 (#1271) Withdraw

Paper ID : A4P-B-30 (#1102)

Approaching the Spatial Resolution Limit of Nano-Gap Fabricated by Focused-Ion-Beam Chemical Vapour Deposition.....N/A

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Nano-gap is the fundamental building block for realizing novel functional devices. However, the resolution limit of nano-gap fabricated by FIB-CVD has still not been synthesized.In this work, we have experimentally studied nano-gap fabricated by using FIB-CVD. The size of nano-gap can be controlled by changing both the ion beam distance design and the ion beam irradiation time. The resolution limit of nano-gap could be promoted to the sub-5-nm regime by using FIB-CVD. We demonstrate that FIB-CVD is a promising technique for high-resolution resistless lithography.

Keywords - Nano-gap, Focused-ion-beam chemical vapour deposition, Spatial resolution limit

Paper ID : A4P-B-31 (#1302)

Design and Simulation of Corrugated Diaphragm Applied to the MEMS Fiber Optic Pressure Sensor.....152

Yiming Gui, Yangxi Zhang, Guandong Liu, Yilong Hao, Chengchen Gao
Peking University, China

In this paper, we propose a corrugated diaphragm applied to the fiber optic pressure sensor which needs a wide sensing range and a large deflection. The corrugated diaphragm can effectively improve the sensitivity of the sensor has been proved by ANSYS simulation. The stress concentration is weakened after the silicon is chamfered into corrugated diaphragm by isotropic etching process. The sensitivity of the corrugated diaphragm can reach to 0.44um/MPa which is two times larger than that of the same size planar diaphragm. The maximum sensing stress is up to 14MPa.

Keywords - Corrugated Diaphragm,Sensitivity,Simulation,MEMS Fiber Optic Pressure Sensor

Paper ID : A4P-B-32 (#1334)

Q Factor Enhancement of a Carbon Mechanical Resonator by Surface Fluorination Using XeF_2 Gas.....N/A

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In this study, the influence of the surface modification using Xenon difluoride (XeF_2) gas on the quality (Q) factor of carbon mechanical resonator was evaluated in order to obtain higher Q factor for the achievement of highly sensitive sensing device. As a result, carbon resonator surface was fluorinated by surface modification using XeF_2 gas. And Q factor was enhanced after fluorination. Enhancement ratio was approximately 1.7 after 60-sec fluorination. In addition, the effect of fluorination decreased gradually with the passage of time.

Keywords - Carbon mechanical resonator, quality factor, surface modification, Xenon difluoride gas, nanoelectromechaanical systems

Paper ID : A4P-B-33 (#1337)

Molecular Dynamics Simulation of Form Measurement Process of Soft Materials Using Atomic Force Microscope.....156

Yindi Cai, Yuan-Liu Chen, Yuki Shimizu, So Ito, Wei Gao
Tohoku University, Japan

MD simulations of form measurement process of soft material using AFM are preformed to investigate the contact behavior and the surface damages or distortions of the measured surface. The simulation-predicted friction force characterizes the saw-tooth pattern, which is referred to as atomic stick-slips. The shape of measured workpiece surface is distorted by the interaction force between the AFM tip and the workpiece surface.

Keywords - MD simulation, soft material, AFM, friction force,surface damages

Paper ID : A4P-B-34 (#1340)

Sensitivity of Nanomechanical Resonator with Gold Nano-Fin Array for Wavelength and Power Detection.....N/A

Etsuo Maeda, Reo Kometani
University of Tokyo, Japan

The wavelength division multiplexer (WDM) is key component to multiplex optical signals onto a single optical fiber for high speed and large capacity communication in fiber-optic-based information systems. In WDM component, wavelength locker is an important device to stabilize the wavelength in optical fiber. For the purpose of cost reduction in the WDM component, we had proposed opto-nanomechanical resonator as a wavelength detection device. Our photonic absorber on nanomechanical resonator was consisted of gold nano-fin array to absorb near infrared light wave which is used in WDM component. The absorbed light wave is translated to thermal stress in the nanomechanical resonator. The minute difference in the illuminated wavelength or power can be measured as the difference in the resonant frequency of nanomechanical resonator. Through our study, the estimated wavelength resolution was 0.2 pm and the estimated power resolution was 0.1 nW with our fabricated opto-nanomehcanical resonator.

Keywords - nanomechanical reonator, near infrared, optical fiber, optical absorption

Paper ID : A4P-B-35 (#1081)

Au-Nanostructured Surface Exhibits Antibacterial Properties.....N/A

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We present here a technological platform for engineering Au nanostructures by using templated electrodeposition. Nanopillars with 50 nm in diameter and various height were fabricated. Rough substrate and various nanostructured surfaces were compared for their abilities to attach and kill bacterial cells. Methicillin-resistant Staphylococcus aureus, a Gram-positive bacterial strain responsible for many infections in health care system, was used as the model bacterial strain. It was found that the Au nanopillars with aspect ratio larger than 2:1 exhibited promising antibacterial property. The cell counting based on fluorescent microscopic images showed that the ratio of dead S. aureus cells on high aspect ratio nanopillars was ~ 80 % compared to ~ 20 % of that from reference rough surfaces. Our micro/nanofabrication process is a scalable approach based on cost-efficient self-organization and provides potential for further developing functional surfaces to study the behavior of microbes on nanoscale topographies.

Keywords - Au nanostructures, fabrication of nanosurfaces, electrodeposition, antibacterial surfaces

Paper ID : A4P-B-36 (#1091)

Engineering Microstructured Polymer Films for Guided Fibroblast Response.....N/A

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Extracellular matrix (ECM) is one of the vital factor to influence behaviours of cells, such as the proliferation, orientation and migration. Topography, roughness and stiffness of substrate surfaces affect the ECM of cultured cells. Various geometries of microstructures on the polymer films, including poly(ε-caprolactone) (PCL) and Poly-dimethylsiloxane (PDMS), were fabricated by utilising a soft imprinting technique. We manufacture the stage, triangle and semi-cylinder microstructures of polymer films, respectively. Interestingly, the elongation speed and density of cultured 3T3 fibroblast cells could be controlled by the dimensions and geometries of microstructures. Therefore, by using the engineering microstructured patterns as a mechanobiology method to control the cellular response is a highly potential and possible approach.

Keywords - cell, microstructure, Polymer

Paper ID : A4P-B-37 (#1189) Withdraw

Paper ID : A4P-B-38 (#1312)

An Electrically Antibody-Manipulated CMOS-MEMS Microcantilever Sensor for Small-Molecule Detection of Anti-Epileptic Drug Valproic Acid.....N/A

Long-Sun Huang, Sheng-Ghih Wu, Chung-Hsien Li, Wei-Je Chen
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We present a standard CMOS-MEMS piezoresistive microcantilever biosensor with electric field enhancement of capture antibody immobilization to be a portable, real-time and quantitative biosensor for drug detection. For patients under the therapeutic drug monitoring that manages therapeutic drug dosage of very narrow concentration in blood, this device shows a potential of fast turn-around-time, low cost and efficient management for point-of-care applications or personal diagnosis. The microcantilever biosensor based on immobilized antibody conformation change for specific recognition is able to yield minute induced surface stresses of cantilever deflection. Especially, this biosensor exhibits unique advantages on small-molecule detection over available label-free biosensors.

Keywords - Valproic acid, CMOS-MEMS, electric field enhancement

Paper ID : A4P-B-39 (#1004)

Evaluation of Fluorine-Based (C4F8) ICP-RIE on a Quartz Glass Substrate for Three-Dimensional Pattern Structure.....N/A

Yu-Hsiang Tang, Che-Chin Chen, Yu-Hsin Lin, Chih-Sheng Yu
National Applied Research Laboratories, Taiwan

In this paper, the etching characteristics of inductively coupled plasma-reactive ion etching (ICP-IRE) on the micro structure of quartz glass were investigated with various parameters, inclusive of C_4F_8 gas, He gas, ICP power, Bias power, chamber pressure and cooling temperature. In the experiment result, which has excellent DC-bias and good verticality, the etched micro structure exhibited a depth of 10 μm and vertical sidewall angle of 90° by means of ICP power 2500 W, bias power 150 W, and chamber pressure at 10 mTorr under a mixture gas of C_4F_8 and He at 24 and 84 sccm of flow rates, respectively. Moreover, the Oxford Plasmalab 100 system etcher was employed for etching the 3D patterns on quartz substrate using a gas of C_4F_8 with 30 sccm, etching pressure of 10 mTorr, ICP power of 2000 W, RF power of 0 W and at room temperature. This establishing was found to achieve a 50 nm/min etch rate, better control of 3D profiles and surface roughness of less than 5 nm.

Keywords - ICP-RIE, Quartz glass, MEMS

Paper ID : A4P-B-40 (#1055)

A Rapid Synthesis of AgCl-Pt-Ag Dendritic Nanotubes for Visible-Light-Active Photoelectrodes.....N/A

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In this paper, extra rapid consecutive galvanic rplacements (GRs) were proposed to prepare AgCl-Pt-Ag dendritic nanotubes (DNTs) for visible-light-active photoelectrodes. The AgCl-Pt-Ag DNTs were used to boost methanol oxidation reaction under visible-light illumination. The oxidation current was boosted by 16% at - 0.2 VSCE of bias. Current results provided a facile and cost-effective approach for preparing free-standing metal-semiconductor composite photoelectrodes.

Keywords - AgCl-Pt-Ag, galvanic replacement, methanol oxidation reaction, visible light, photoelectrodes

Paper ID : A4P-B-41 (#1075)

Micro-Hyperboloid Lensed Optical Fibers for Laser Chip Coupling.....164

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This study develops a novel approach for producing micro-hyperboloid lensed fibers for high-power laser chip coupling. A hyperboloid lens structure was directly produced with a flat-end single mode fiber with the core diameter of 6.6 μm. A precision mechanical grinding following a spin-on-glass (SOG) electrostatic pulling method is used to produce micro-hyperboloid lens with the short-axis radius of curvature of around 4.0~5.0 μm. A high coupling efficiency around 80% is obtained while using the produced hyperboloid fibers, which was about 40% increment compared to the flat end fiber. The averaged coefficient of variation (C.V.%) of the coupling stability for 5 individual hyperboloid fibers is 0.116±0.044%, indicating the good stability for the produced micro-hyperboloid lenses. The developed method provides an efficient way for producing micro-hyperboloid lensed fibers for high performance diode laser coupling.

Keywords - hyperboloid microlens, spin on glass, electrostatic pulling, microlensed fibers, coupling efficiency

Paper ID : A4P-B-42 (#1113)

Development of Compact GHz-Band Current Sensor.....N/A

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We developed a new compact GHz-band current sensor using a polymer laminated substrate with low permittivity and low parasitism capacitance. We used liquid crystal polymer which permittivity is 3.0. The sensor consists of thin film coil formed onto laminated layers with thickness of 50 μm. The laminated substrate with low permittivity and low parasitism capacitance will be easily applied to many kinds of circuit components and sensors in disfavor with parasitism capacitance.

Keywords - current sensor, laminated substrates, coil

Paper ID : A4P-B-43 (#1115)

Superhydrophobic Surface on PTFE Coated Network-Type Microstructures.....N/A

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We have developed the superhydrophobic surface by DRIE and PTFE coating of a silicon substrate. DRIE process has produced quadrilateral network-type silicon microstructures. The sputtering of the PTFE thin film over the microstructures created a superhydrophobic surface. The fluorinated polymer also exhibited hydrophobicity properties. The contact angle of silicon substrate after the PTFE coating was 108.4°. After the RIE etching procedure and PTFE coating, the contact angle increased up to 147.8° and 156.9°. When SAM is coated on microstructures or on PTFE on microstructures, the contact angles are increased up to 163.2° and 159.4°, respectively.

Keywords - superhydrophobic, PTFE, Network-type, SAM

Paper ID : A4P-B-44 (#1164)

High-Speed and Simple Nanoscale Lithography by Local Heating for Micro-Nanoscale Fluidic Channel.....N/A

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We have succeeded in fabricating nano-scale channel by high-speed nanolithography technique which is based on the thermal lithography using optical heating with a high resolution of less than several-hundred nm. The novelty of the study is using thermal expansion of photoresist which is located under the thin layer of chrome illuminated by laser light as indirect thermal source. The laser (1064 nm, laser spot size = 650 nm) whose positioning accuracy is about 1nm in x, y, z direction, scans along the patterned chrome layer and the heat expansion of photoresist which is on the chrome layer narrowed the microchannel to produce nano-channel wherever it required. By using this lithography technique, it is possible to fabricate simple nano-scale channel with a cross-section of several hundred nm high and width. This thermal lithography provides novel low cost and very simple process to fabricate nano-scale fluidic channels.

Keywords - Nano-micro-channel, laser, thermal expansion, lithography

Paper ID : A4P-B-45 (#1215)

Steerable Trajectory of Gold-Nickel-Platinum Nanojets with Nozzle Nanoengines.....N/A

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Rockets can orbit around Earth and control their motion direction using self-equipped jet engines in the space. Inspired by the manmade rockets, tiny nanojets are designed, which have a form of disk comprising of three different metals: gold (Au), nickel (Ni) and platinum (Pt). The steerable propulsion mechanism of the nanojets is proposed. Nanojets with one off-center Pt nozzle nanoengine are for the first time fabricated by a layer-by-layer deposition method based on nano-electro-mechanical systems (NEMS) technology. The steerable trajectories of the nanojets with one Pt nozzle nanoengine are characterized in the diluted hydrogen peroxide (H_2O_2) solution. As a consequence, Au-Ni-Pt nanojets can autonomously move forward circularly at a speed of 300 μm/s, resulting from the Pt nozzle nanoengines are only located on one side of the nanojets. This work advances the research on the steerable trajectories of the nanojets using metal nozzle nanoengines.

Keywords - disk-like gold-nickel-platinum nanojet, steerable trajectory, platinum nozzle nanoengines, hydrogen peroxide, oxygen bubble

Paper ID : A4P-B-46 (#1226)

Plasma Half Dicing Based on Micro-Loading Effect for Ultra-Thin $LiNbO_3$ Plate Wave Devices on Si Substrate.....168

Yoshimi Yunoki, Michio Kadota, Masaaki Moriyama, Shuji Tanaka
Tohoku University, Japan

A cognitive radio system using a vacant frequency band of digital TV (DTV) channels requires ultra-wideband resonators and filters, which require a substrate with a large coupling factor. A 0th shear horizontal (SH0) mode plate wave in a (0º, 117.5-120º, 0º) $LiNbO_3$ (LN) thin plate thinner than 0.1λ(λ: wavelength) has a larger coupling factor k2 than 50%. So, the SH0 plate wave devices for the DTV band are reported using ultra-thin LN plate of 0.5 to 0.6 μm. Chips of the devices must be separated to mount on a print circuit board from a LN/Si wafer with a lot of device chips. Authors developed a new separating method applying a micro-loading effect instead of conventional dicing by a dicing machine. This method has an advantage of not using strong water shower after fabricating cavities, which sometime give a damage on the chip surface over the cavity.

Keywords - Micro-loading effect, plate wave, resonator devices, RIE, separating

Paper ID : A4P-B-47 (#1246)

Out-of-Plane Cup Shaped Stainless Steel Microneedle Array for Drug Delivery.....172

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In order to improve the transdermal delivery of drug several techniques have been reported (Chemical, Iontophoresis, Sonophoresis and microneedle). Among these techniques, the microneedle technology gained more attention in recent years. Mainly, two types (Solid and Hollow) of microneedles have been reported for the successful drug delivery application. In this paper, we report the fabrication of out-of-plane solid Stainless Steel (SS) microneedles and formation of microcup structure within them suitable for drug delivery application. Array of out-of-plane solid SS microneedles were fabricated using Electric Discharge Machining (EDM) method. Subsequently, the microcup structures on the solid SS microneedles were formed using Focused Ion Beam (FIB) technique. The microcup structure on the microneedles acts as a dedicated region to fill the drug, so that the possible drug leakage while inserting the microneedles into the skin can be avoided. The drug filling into the microcup structures was performed using drop coating method. This coating method in combination with cup shaped microneedle array enables to deliver multiple drugs simultaneously in desired proportion.

Keywords - MEMS, Microneedles, drug delivery

Paper ID : A4P-B-48 (#1289)

Compound Reflective Curves with Metallic Glass Thin Film for Exposure System.....N/A

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In this study, light-emitting diode (LED) is applied to replace the halogen lamp. Based on geometrical optics and reflection law, a module of collimated reflective curved surface is established. An additional elliptic reflective curved surface is combined with collimated surface to enhance the uniformity of illumination. This design can be used as exposure system, which meets the exposure specification and also keep up with trend of environmental protection. Al-based thin film metallic glass (TFMG) was used as the reflective layer, which exhibits excellent forming ability and high reflectivity. According to the results of simulation and measurement, the average irradiance, uniformity and the half-angle are consistency. The critical experimental dimension of 5μm after exposure can be obtained, which can be comparable with commercial one.

Keywords - exposure system, light-emitting diode, elliptical curve

Paper ID : A4P-B-49 (#1305)

"Water of Things" for Controlling Surface Hydrophobicity of Large-Scale and Flexible Substrate.....N/A

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Here we launched a transfer printing method by using colloidal templating to fabricate a large-scale and flexible substrate with controllable surface hydrophobicity. We successfully fabricated a large-scale and flexible substrate for surface morphology detecting and contact angles testing. Our study could effectively implement large-scale and flexible hydrophobic substrate and could be extended for future applications in flexible sensors and actuators.

Keywords - surface hydrophobicity, waster assisted, colloidal tempalting

Paper ID : A4P-B-50 (#1308)

Piezoelectric Transducer Array Microspeaker.....180

Armando Arpys Arevalo{1}, David Conchouso{1}, David Castro{1}, Jurgen Kosel{1}, Ian G Foulds{2}
{1}King Abdullah University of Science and Technology, Saudi Arabia; {2}King Abdullah University of Science and Technology / University of British Columbia, Canada

In this paper we present the fabrication and char- acterization of a piezoelectric micro-speaker. The speaker is an array of micro-machined piezoelectric membranes, fabricated on silicon wafer using advanced micro-machining techniques. Each array contains 2n piezoelectric transducer membranes, where “n” is the bit number. Every element of the array has a circular shape structure. The membrane is made out four layers: 250 nm of platinum for the bottom electrode, 250nm or lead zirconate titanate (PZT), a top electrode of 250 nm and a structural layer of 5′μm made of polyimide. The wafer layout design was diced in nine chips with different array configurations, with variation of the membrane dimensions. The device was tested with different voltages obtaining good sound output levels by using only 3 V .

Keywords - PZT, Digital Sound Reconstruction, Acousti Membranes, Polyimide

Paper ID : A4P-B-51 (#1056) Withdraw

Paper ID : A4P-B-52 (#1071)

Scaling Analysis of Capacitive MEMS Microphones Considering Residual Stress.....184

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We conduct a systematic scaling analysis of the sensitivity of a silicon capacitive MEMS microphone based on a dimensionless 1-degree-of-freedom (1DOF) model considering residual stress. The theoretical normalized sensitivity we derived is a nonlinear function of normalized diaphragm size (h/a), acoustic driving frequency, 3 effective stiffness terms and the other parameters. From our 1DOF model, the optimal normalized diaphragm has to be trade-off between high sensitivity and large bandwidth. In addition, we found that a critical diaphragm radius of 415 um for a silicon MEMS microphone, is located at the inflection point in the sensitivity function of the radius. In addition, this critical radius corresponds to the minimum effective stiffness of the microphone.

Keywords - MEMS microphone, scaling analysis, residual stress, sensitivity

Paper ID : A4P-B-53 (#1107) Withdraw

Paper ID : A4P-B-54 (#1122)

Design and Analysis of a Single-Structure Three-Axis MEMS Gyroscope with Improved Coupling Spring.....188

Muhammad Ali Shah, Faisal Iqbal, Byeung-Leul Lee
Korea University of Technology and Education, Korea, South

This paper reports the design and analysis of a single drive mass three axis Microelectromechanical systems (MEMS) gyroscope. The proposed MEMS gyroscope contains a unique and simple coupling spring to couple the driving masses. Due to the use of this coupling spring, the stress effect on the spring ends is reduced as it is attached at two points with the driving mass. Moreover, the unwanted motions of the driving mass can be suppressed due to the use of the two spring beams for the support of the central spring. After FEA simulation using COMSOL Multiphysics tool, a first driving mode of the proposed design has been achieved. Other modes were achieved for the pitch, roll and yaw sensing parts. The simulated resonant frequencies are 15.20 kHz for the driving mode, 15.21 kHz for the pitch sensing mode, 15.32 kHz for the roll sensing mode and 15.59 kHz for the yaw sensing mode, respectively.

Keywords - MEMS gyroscope

Paper ID : A4P-B-55 (#1275)

Design of a Graphene Capacitive Pressure Sensor for Ultra-Low Pressure Detection.....192

Yangxi Zhang, Yiming Gui, Fanrui Meng, Chengchen Gao, Yilong Hao
Peking University, China

This paper reports the design and theoretical calculation of a capacitive ultra-low pressure sensor, which is based on circular suspend graphene diaphragm array. The atom scale thickness and high mechanical strength of suspend graphene diaphragm both contribute to ultra-low pressure measure range. As the area of single circular graphene diaphragm is limited by fabrication process, a sensor array is designed to achieve detectable capacitance change and redundancy. In calculation, a sensor array with 40,000 5 μm radius suspend graphene diaphragm cells in 4mm×4mm size can provide 288fF/Pa sensitivity to pressure load.

Keywords - graphene, capacitive sensor, ultra-low pressure

Paper ID : A4P-B-56 (#1017)

Analysis of the 3 Omega Method for the Measurement of Fluid Thermal Properties.....196

Xiangxiang Huang{1}, Rahman Hebibul{2}, Libo Zhao{1}, Tingzhong Xu{1}, Yulong Zhao{1}, Zhuangde Jiang{1}
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Generally, the 3ω method for the measurement of thermal properties of fluid is based on an approximate solution to heat conduction model assuming vanishing heater-thickness, no dielectric layer and infinite heater-length. In this study, a novel three-dimensional model and partial differential equations (PDEs) of the dimensionless heating conduction in frequently domain were established, which took into account the finite thicknesses of the heater and dielectric layer as well as a finite heater length to investigate thermal conductivity and diffusivity of fluid. Through the numerical studies, it was found that we could reduce the ratio of thickness to width of heater or the thickness and thermal conductivity of the dielectric layer to minimize discrepancy between the numerical results and the approximate solutions. Additionally, the edge effects of a finite heater length can be ignored at low measurement frequencies and high ratio of length to width of the heater.

Keywords - 3ω, Thermal property, Numerical analysis

Paper ID : A4P-B-57 (#1114)

Water Strider Robot with Micro/Nano Textured and PTFE Coated Surface Feet.....N/A

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We have developed the fabrication process of superhydrophobic surface with micro/nano texturing method. The contact angle of micro-pyramid was 165.1° after the PTFE coating. The textured surface was applied to feet of water strider. From the results, we know that the moving time was improved in 0.32 second because of the hydrophobicity coating. Therefore, the PTFE coated surface can be successfully applied to reduce the moving time of the water strider robot.

Keywords - Water stride, PFTE, superhydrophobic

Paper ID : A4P-B-58 (#1145)

CMOS MEMS Infrared Source Based on Black Silicon.....200

Weibing Liu{3}, Anjie Ming{1}, Yaohui Ren{3}, Qiulin Tan{3}, Wen Ou{1}, Xilong Sun{2}, Weibing Wang{1}, Dapeng Chen{1}, Jijun Xiong{3}
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In this work, a CMOS MEMS infrared (IR) source applied to compact NDIR gas sensor is reported. Compared to other related works, the designed IR source coats integrated nano-scale black silicon compatible with CMOS process on the heavy doped poly-silicon radiation membrane. Hence the emissivity can reach as high as 98% at 2-5μm wave range and relatively the radiation efficiency is increased by 40%. Suspended radiation membrane with four slim legs released by back-side DRIE process is adopted in this design to reduce the heat conduction losses and the source is only sized 3×3 mm^2 suitable for mass production. After being TO39 package, the IR source can be rapidly heated in 20ms and the modulation depth can reach 30% at 50Hz which meet the requirements of the NDIR gas sensor.

Keywords - Infrared source,Black silicon,MEMS

Paper ID : A4P-B-59 (#1191)

Investigation of Interface Between Ge Electrodes and Ionic Liquid Electrolyte for Development of Electric Double Layer Capacitors.....205

Reshan Maduka Abeysinghe, Hiroyuki Oguchi, Motoaki Hara, Hiroki Kuwano
Tohoku University, Japan

This study demonstrated that electrical double layer capacitors (EDLC) can be fabricated using Ge electrodes and ionic liquids. We found that the ionic liquids must be dried for the use of electrolytes of the EDLCs because water causes chemical reaction with Ge. This chemical reaction is, however, useful to make porous structures on the Ge to prepare large surface area electrodes essential to the EDLCs. In addition, ionic liquid used for the chemical reaction can fill the complex Ge pores. Based on these findings, we prepared the EDLCs composed of Ge porous electrodes and the ionic liquid electrolyte. By drying the ionic liquid at 100 °C, the device showed reasonable electrochemical behavior as the EDLCs.

Keywords – Ge porous structure formation, EDLC interface investigation, IL reactiveness

Paper ID : A4P-B-60 (#1303)

Design and Simulation of MEMS Thermal and Vibration Isolator Based on PDMS Beam Arrays.....213

Kaisi Xu, Ningli Zhu, Shan Cao, Weiguo Su, Wei Zhang, Yilong Hao
Peking University, China

This paper proposes a MEMS thermal and vibration isolator to be integrated with micro devices. The isolator is able to generate an attenuated thermal and vibration condition via lock-shaped PDMS beam arrays due to the ultra-low thermal conductivity and Young modulus of PDMS. Thermal simulations have been carried out to indicate the efficient heat resistance of the isolator in both static and transient heat transfer processes. Several harmonic response simulations have also been conducted to test the performance of vibration isolation. Results show an obvious frequency shift and approximately 40μm decrease in response deformation. This approach decouples the harsh environment resistance design from the device design, guaranteeing device performance in both thermal and vibration working conditions. It may broaden the application domains of MEMS devices, especially in military and space missions.

Keywords - MEMS Reliability, Thermal Isolation, Vibration Isolation, PDMS Beam

Paper ID : A4P-B-61 (#1120)

Inverse Eigenvalue Analysis Techniques for Coupled M/NEMS Resonators.....217

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University of Oxford, United Kingdom

M/NEMS resonators are widely used as mass sensors. Coupled resonators have emerged as a promising candidate for multifunction sensing while reducing the number of interconnections and pads. Coupling between these sensors enables control and characterization of the entire array by driving/reading from only one element. Inverse eigenvalue analysis utilizes the eigenvalues recorded from the response of one single resonator to inversely reconstruct the system matrix of all resonators. We compare two inverse eigenvalue analysis techniques to characterize coupled M/NEMS resonators. The first technique perturbs the spring constant of one element, while the second couples an additional resonator to the array. Both techniques showed high accuracy in extracting the actual characteristics of a simulated array of resonators. However, when studied for performance in noisy situation, the second technique shows better accuracy. Furthermore, the second technique is easier to implement by using a simple electrical resonator. Inverse eigenvalue analysis can be used to actuate single input single output multifunction sensors and monitor micro/nano fabrication variabilities.

Keywords - M/NEMS, coupled resonators, inverse eigenvalue analysis, sensor

Paper ID : A4P-B-62 (#1211)

A Lead-Free Micro Thermal Bubble Atomizer for Aromatherapy Applications.....N/A

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We present our development of a novel atomizer (i.e., a mist generator) constructed by integrating micro-heaters and micro-nozzles, which are used to actuate micro thermal bubbles. It is a simple, low cost and most importantly, environmental friendly (i.e., lead-free) design which can be used in healthcare industries. Another advantage is that our atomizer has been tested to be applicable with a wide range of fluid viscosity ranging from 1cp (e.g., water) to 65cp (i.e., oil-like fluid). The design, fabrication and characterization of the atomizer will be presented at the conference. Experimental results indicate the average power consumption of the atomizer is ~ 0.2W with an atomization rate of 0.3mg/cycle. The size of the atomizer is 16mm in diameter with an effective orifices region of 5.5mm in diameter.

Keywords - Thermal bubble, atomizer, nebulizer, mist generators

Paper ID : A4P-B-63 (#1280)

Miniaturization of Zn/Br Redox Flow Battery Cell.....221

Yoshiki Nagai, Ryohei Komiyama, Hidetoshi Miyashita, Sang-Seok Lee
Tottori University, Japan

Redox flow battery is one of secondary batteries, which is a kind of a fuel cell because it also utilizes active material supplied externally. It has been paid attention since it has been considered as a solution for large-scale energy storage. We miniaturized the cell of Zn/Br redox flow battery as an energy source for a sensor node of wireless sensor network systems. In this paper, we report the fabrication and the experimental results for performance characteristics of the miniaturized Zn/Br redox flow battery cell.

Keywords - Redox Battery, Miniaturization, Electrode Material

Paper ID : A4P-B-64 (#1306)

Digital Electrostatic Acoustic Transducer Array.....225

Armando Arpys Arevalo{1}, David Castro{1}, David Conchouso{1}, Jurgen Kosel{1}, Ian G Foulds{2}
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In this paper we present the fabrication and char- acterization of an array of electrostatic acoustic transducers. The array is micromachined on a silicon wafer using standard micro-machining techniques. Each array contains 2n electrostatic transducer membranes, where “n” is the bit number. Every element of the array has a hexagonal membrane shape structure, which is separated from the substrate by 3μm air gap. The membrane is made out 5μm thick polyimide layer that has a bottom gold electrode on the substrate and a gold top electrode on top of the membrane (250 nm). The wafer layout design was diced in nine chips with different array configurations, with variation of the membrane dimensions. The device was tested with 90V giving and sound output level as high as 35dB, while actuating all the elements at the same time.

Keywords - Acoustic Transducer, Digital Sound Reconstruction, Parametric Speakers

Paper ID : A4P-B-65 (#1502)

A High-Speed Image Super-Resolution Algorithm Based on Sparse Representation for MEMS Defect Detection.....229

Xiuyuan Li, Yulong Zhao, Tengjiang Hu, Qi Zhang, Yingxue Li
Xi'an Jiaotong University, China

A novel high-speed image super-resolution algorithm based on sparse representation for MEMS defect detection is proposed in this paper. Traditional super-resolution algorithms adopt a single dictionary to represent images, which cannot differentiate varieties of image blocks and leads to slow processing speed. Aiming at overcoming this shortage of traditional super-resolution algorithms, image blocks are divided into different categories by local features and each of these categories possesses the corresponding high and low resolution dictionary pairs. Experimental results of different MEMS defects show that the improved algorithm can obtain images of little higher quality with much less processing time,indicating that the proposed algorithm is more suitable for MEMS defect detection.

Keywords - MEMS defect detection,high-speed,image super-resolution,sparse representation

Paper ID : A4P-B-66 (#1511)

Sub-30 nm Pattern Collective Transcription by Thin-Film Edge Electrode Lithography.....N/A

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A new lithography method using thin-film edge electrodes was investigated to collectively transfer nano patterns by generating oxide on the substrate surface via the anodic oxidation reaction. Thin-film edges of a few tens nm in width were formed on the sidewall of a silicon-based mold. The anodic oxidation reaction took place in the small water meniscus between the edge electrode and the substrate. This time, Cytop® thin film was added to the mold to control the meniscus formation. Oxide nanopatterns of sub-30 nm in width were collectively transferred on Si substrate in a millimeter-scale area.

Keywords - Thin-film edge electrode, anodic oxidation reaction, collective transcription, lithography

Paper ID : A4P-B-67 (#1516)

Resonant Frequency Tunable Silicon Fishbone-Shaped MEMS Double Ended Tuning Fork.....233

Hong Ding, Lifeng Fu, Yixiang Wang, Jin Xie
Zhejiang University, China

In this research, a resonant frequency tunable silicon fishbone-shaped MEMS (micro-electro-mechanical systems) double ended tuning fork is presented, which realizes digitally tunable resonant frequency function.

Keywords - resonator, double ended tuning fork, fishbone, MEMS

Paper ID : A4P-B-68 (#1520)

Automated Micro-Object Caging Using Bubble microrobots.....237

Noboru Takahashi
Chiba Institute of Technology, Japan

Four bubble opto-thermocapillary flow-addressed (OFB) microrobots were actuated to cage a microbead. These microrobots were created and actuated using an open-loop feedback system, with an image-processing algorithm to determine optimal paths for each microrobot. This work demonstrates the possibility of controlling multiple microrobots with feedback for automated micro-assembly.

Keywords - Microrobot, Casing, OFB,

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Paper ID : B3P-B-1 (#1010)
Superfocusing Properties of Metallic Planar Lens Based on Coupled Width-Variable Nanoslits.....N/A
Yechuan Zhu, Weizheng Yuan, Yiting Yu, Ping Wang
Northwestern Polytechnical University, China
The effects of various factors such as the lens size, focusing distance and working medium on the superfocusing properties of the planar lenses formed by the coupled width-variable nanoslits perforated in a metallic film are systematically investigated. Based on the geometrical optics and the wavefront reconstruction principle, the array of nanoslits is optimally designed for the lenses to achieve the desired phase modulation by combining the influence of the coupling between aperiodic nanoslits on the phase delay and the theory of periodic metallic waveguide. The finite-difference time-domain (FDTD) algorithm is utilized to validate the focusing behavior of the designed lenses. The simulation results agree well with the design. Furthermore, we find that the larger lens size, the shorter focusing distance and the higher-index working medium can produce a better superfocusing performance. A focusing spot of λ/4.39 is ultimately obtained using an oil immersion metallic planar lens with an aperture size of 4.83λ at the focusing distance of 0.3 μm.
Keywords - Superfocusing, Metallic planar lens, coupled nanoslits

Paper ID : B3P-B-2 (#1224)
Effect of Grating Profile on the Infrared Wavelength Coupled with Surface Plasmon Polariton.....N/A
Shuga Yahagi, Shinya Kumagai, Minoru Sasaki
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Plasmonic thermal emitters are promising for generating specific infrared light. The plasmonic thermal emitter uses periodic grating structures. This grating structure and the incident infrared light are coupled generating the surface plasmon polariton. The surface plasmon polariton emits the selected infrared light. Here, the periodic structure of grating was analyzed for selectively generating infrared light.
Keywords - gas sensor, infrared, plasmonic thermal emitter, surface plasmon polariton

Paper ID : B3P-B-3 (#1065)
Effects of Annealing Process Parameters on Microstructure and Electrical Performance of $Pb(Zr_{0.52}Ti_{0.48})O_3$ Thin Film Fabricated by Sol-Gel Method.....N/A
Huajun Sun{2}, Gang Wang{2}, Xiaofang Liu{2}, Dawei Wang{1}, Huiting Sui{2}, Liang He{2}
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A series of $Pb(Zr_{0.52}Ti_{0.48})O_3$ (PZT) thin films with (110)-preferred orientation have been successfully prepared on $Pt/Ti/SiO_2/Si$ substrates by a sol-gel method. The effects of annealing process parameters, namely annealing temperature and duration time, on the microstructure and electrical properties of PZT thin film were investigated. All the films show pure perovskite structure with full compaction. Among all, the one annealed under 800°C for 10 min exhibits superior ferroelectricity with a higher remnant polarization (2Pr) and coercive field (2Ec) of 40.60 μC/cm^2 and 59.85 kV/cm, respectively. This can be due to the fact that under the certain condition, the film sample is well-crystallized with high densification and appropriated grain size. Also, its dielectric properties tend to be better with a relatively higher dielectric constant (εr) and lower dielectric loss (tanσ) of 1763 and 0.0984, respectively. Meanwhile, it reveals piezoelectricity with a longitudinal effective piezoelectric coefficient (d33) of 120 pm/V.
Keywords - microstructure,piezoelectric, ferroelectric,dielectric

Paper ID : B3P-B-4 (#1074)

Removal of Aqueous Metals from Wastewater Using Porous Functional Heterocyclic Aromatic Amines.....414

Ray-Wen Hsu, Hung-Lun Liao, Pen-Cheng Wang
National Tsing Hua University, Taiwan

In this work, the applicability of poly aromatic amines (PAA) for the removal of gold and copper from various water samples has been investigated. Batch experiments were performed to realize the effect of relative nitrogen/carbon composition on the ability of PAA for removal of aqueous metals to achieve quantitative separation of metal. Besides, the effect of monomer structures on the morphology of polymerized aromatic amines was studied. Several polymerized aromatic amines were prepared by oxidative chemical. ICP-MS was used to determine the content of matals in the initial and final sample solutions to calculate metal uptake. The morphology was examined using scanning electron microscopy. Besides, the C/N ratio of the polymers was investigated by element analysis (EA).

Keywords - Poly Aromatic Amine,Removal of Gold and Copper

Paper ID : B3P-B-5 (#1085)

Composite Process to Fabricate Low Impedance and Long Electrical Stability Platinum Gray Microelectrodes Using Iridium Oxide.....442

You-Lin Yin{2}, Kai Xia{2}, Yan Li{2}, Tian-Zhun Wu{1}, Ming-Hua Tang{3}
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{2}Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China; {3}Xiangtan University, China

The stability and availability of implantable microelectrodes for chronic neural stimulation mainly depends on the electrode surface materials. In this paper, the performances of platinum (Pt) gray/ iridium oxide (IrOx) and IrOx /Pt gray composite electrodeposition and compared with pure Pt gray or IrOx were investigated. The Surface morphologies of different modified electrodes were characterized by scanning electron microscopy (SEM). IrOx had dendritic morphology while Pt gray had granular morphology. Electrochemical impedance spectroscopy (EIS) and cyclic voltammetry (CV) tests were the most commonly used effective characterization methods, which have demonstrated that these IrOx/Pt gray platinum electrodes perform oPtimally for the lowest impedance and the longest stability.

Keywords - Platinum Gray, Iridium Oxide, Low Impedance, Long Electrical Stability

Paper ID : B3P-B-6 (#1103)

New Coarse-Grained Molecular Dynamics Model of Double Stranded DNA Chain for DNA Origami.....464

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New coarse-grained molecular dynamics model of double stranded DNA (nCG-dsDNA model) was reported. The nCG-dsDNA model was made by newly developed simple bead-spring model for realizing a helix structure. The phosphate group, sugar group, and base group in an actual double stranded DNA chain were represented by a single bead. The nCG-dsDNA model with 202 base pair was utilized to tune the bond potential between connected two beads of a chain, the nonbond potential between stack sites and the angle bending potential between three beads. The twisted angle of each chains in the model was calculated as 35.3 degrees. From this result, it was confirmed that the actual double stranded DNA structure was well realized by the proposed model. Moreover, it was confirmed that a persistence length of the nCG-dsDNA model was in good agreement with the results of conventional DNA model (oxDNA model) and experiments.

Keywords - Molecular Dynamics, Persistence Length, Base Pair, Origami

Paper ID : B3P-B-7 (#1154)

Microstructuring of Carbon/Tin Composite via a Novel Photolithography and Pyrolysis-Reduction Process.....N/A

Xufeng Hong, Zhimeng Hao, Shuxuan Feng, Ruiqi Zhu, Yue Huang, Yan Tong, Fen Mei, Liang He, Liqiang Mai
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A novel microfabrication process based on the optimized photolithography combined with the pyrolysis-reduction was realized to fabricate the interdigitated porous carbon/tin (C/Sn) nanocomposite micro-supercapacitors. Sn quantum dots (QDs) based C/Sn nanocomposite is utilized as electrode active material and the current collector, which makes the microfabrication process of the micro-supercapacitors a simple approach and compatible with micromachining technologies. The electrochemical properties of the micro-supercapacitors are characterized, such as current-voltage (CV), capacitance and charge-discharge, etc. The results showed that the supercapacitors based on the nanocomposite pyrolyzed at 900 °C has high capacitance of 4.99 mF/cm^2 at a scan rate of 5 mVs^{-1}.

Keywords - Carbon, Tin, Composite, Capacitor, Pyrolysis

Paper ID : B3P-B-8 (#1198)

Carbon Nanostructures Synthesized via Self-Assembly (LLIP) and its Application in FET.....468

Karthik Paneer Selvam{2}, Yuma Shimo{2}, Zaw Lin{2}, Venkata Krishna Rao R{2}, Xiao Gong{2}, Mitsunobu Yoshida{2}, Masaki Hada{2}, Takeshi Nishikawa{2}, Yasuhiko Hayashi{2}, Singh SP{1}
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Here in, we report carbon nanostructures (nanorods) synthesized via liquid-liquid interface precipitation method (LLIP) with its application in field effect transistor as gate terminal. The carbon nanorods were synthesized by supersaturating and shape shifting Bucky ball fullerene into nanorods. The nanoparticles synthesis process is fast, efficient and the reaction is carried out in 24hrs. The obtained nanorods were found to have semiconducting property which was confirmed by analyzing TEM, SEM and RAMAN, FET analysis by IV measurements. Hence the nanorods where fabricated as gate terminal in field effect transistor.

Keywords - Carbon, Nanotechnology, Micro Electronics, Self-Assembly

Paper ID : B3P-B-9 (#1317)

Sharp Photoluminessence from Localized Excitons in Monolayer Tungsten Disulfide.....N/A

Toshiaki Kato, Toshiro Kaneko
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A photoluminescence (PL) peak has been observed from a monolayer tungsten disulfide, which is one of the transition metal dichalcogenide (TMD) and known to be an ideal 2D semiconductor. The PL peak appears near the low-energy side of neutral free excitons with very sharp peak width (~ 10 meV) at low temperature (83 K). Systematic temperature-dependent PL measurements reveal that the peak can be explained by bound excitons being trapped by the surface impurities, which results in a highly localized state for the excitons. Since the optically detectable, highly localized impurity state promises to have extensive practical applications for quantum optics, our finding represents an important step in the study of 2D materials for use in quantum computation and information.

Keywords - Photoluminessence, TMD, WS2, localized excitons

Paper ID : B3P-B-10 (#1328)

One-Dimensional Nanomaterials for Energy Storage.....N/A

Liqiang Mai, Xiaocong Tian, Lin Xu, Qiulong Wei
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One-Dimensional nanomaterials with large surface area, more surface active sites and better permeability can significantly increase the energy density, power density and cycling performance for the energy storage. Such hierarchical structure can also be used as targeted intracellular recording for its facile synthesis route. In our present work, a series of hierarchical nanomaterials have been obtained, including kinked hierarchical nanowires, hierarchical heterostructured nanowires and hierarchical scrolled nanowires which shows great electrochemical. To increase the stability of Li-ion battery, V_3O_7 nanowire templated semi-hollow bicontinous graphene scrolls architecture is designed and constructed through “oriented assembly” and “self-scroll” strategy. The V_3O_7 nanowire templated semi-hollow bicontinous graphene scrolls with interior cavities provide continuous electron and lithium ion transfer channel and space for free volume expansion of V_3O_7 nanowires during cycling, thus representing a unique architecture for excellent lithium ion storage capacity and cycling performance. Besides, we have designed and synthesized hierarchical $MnMoO_4/CoMoO_4$ heterostructured nanowires by combining "oriented attachment" and "self-assembly". The asymmetric supercapacitors based on the hierarchical heterostructured nanowires show a high specific capacitance and good reversibility with a cycling efficiency of 98% after 1,000 cycles. Recently, we also constructed the hierarchical zigzag $Na_{1.25}V_3O_8$ nanowires, $K_3V_2(PO_4)_3$ bundled nanowire, and $Li_3V_2(PO_4)_3$ mesoporous nanotubes with enhanced electrochemical performance. Our work presented here can inspire new thought in constructing novel nanofiber/nanowire structures and accelerate the development of energy storage appilications.

Keywords - One-Dimensional, Nanomaterials, energy storage

Paper ID : B3P-B-11 (#1146)

Negative Temperature Coefficient Behavior of Graphene-Silver Nanocomposite Films for Temperature Sensor Applications.....329

Nagarjuna Neella, Venkateswarlu Gaddam, Konandur Rajanna, Mm Nayak
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We are reporting the fabrication of Reduced Graphene Oxide (RGO) " Silver (Ag) nanocomposite films for temperature sensor application on the basis of negative temperature coefficient (NTC) resistive element. For the fabrication of temperature sensor, the sensing film formation is carried out on the flexible kapton membrane by using drop casting method. The thickness of the sensing film is around 50 µm. It was observed that the resistivity of nanocomposite sensing film decreased with the increase of temperature resulting in NTC behavior. The measured NTC and sensitivity of the sensor were found to be -0.00187 Ω/Ω/K and 0.40472 Ω/K respectively.

Keywords - Temperature Sensors, Graphene-Silver nanaocomposite, NTC

Paper ID : B3P-B-12 (#1297)

Photoresponse Measurement of Carbon Nanotube Based Infrared Photodetector Using Digital Microscope.....333

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Michigan State University, United States

The conventional infrared sensors suffer from trade off between sensitivity and cost. The bolometer infrared camera is low resolution and slow speed while the quantum photodetectors are bulky and expensive. In this paper, the novel low dimensional materials carbon nanotube based Schottky barrier structure non cryogenic IR detector was designed to detect IR irradiance. In order to characterize the photodetector, a testing bench using digital microscope and precise linear stage was used to measure detector performance. The experimental results show that the quantum effect dominates photoresponse in CNT based IR sensor and the photodetector responsivity can reach to 20 mA/mW at 850 nm wavelength. The proposed method will be applicable for 1D/2D nanoscale material based photodiode characterization.

Keywords - Carbon Nanotube, Infrared, Photodetector

Paper ID : B3P-B-13 (#1150)

Design and Experimental Validation of a Piezo-Driven MAV Flapping Wing Mechanism.....N/A

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This paper presents a novel a piezo-driven flapping wing mechanism for micro air vehicles (MAVs). The flapping wing mechanism is a crank-slider mechanism driven by a linear actuator which consists of a piezoelectric element (PZT) and a permanent magnet. The linear actuator serves as a slider of the mechanism and can be driven with a long range based on the principle of impact friction drive. The linear actuator can be driven with a reciprocating linear motion continuously when changing the input saw-tooth voltage alternately, which can be directly converted to a flapping motion via the crank-slider mechanism. Compared with conventional flapping wing MAVs driven by a rotary motor, no gearbox is needed in the proposed design. Therefore, the proposed flapping wing mechanism can be made with small volume and light weight. The results of experiments confirmed that the developed mechanism can achieve a continuous flapping motion by moving the linear actuator in a reciprocating manner.

Keywords - micro robots, piezoelectric, actuator, flapping wing

Paper ID : B3P-B-14 (#1032)

Quantification of Cancer Cell Colonies Based on Optical Coherence Microscopy in 3D Environment.....N/A

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Cancer is one of the major causes of death worldwide. There are 820 million people died of cancer in 2012. Two-dimensional (2D) cell culture model is commonly used in the in vitro cell-based assays. Recently, some studies have pointed out three-dimensional (3D) cell culture model has better physiological meaning to simulate the in vivo environment. However, traditional practice of observing colonies is to use dye Calcein-AM staining to distinguish live cells and impurities. This method is based on microscopic imaging; thus, it is a subjective quantification technique. In this work, we developed an optical coherence microscopy (OCM) system to quantify cancer cell colonies in 3D environment. This method is real-time and non-invasive optical method. It can provide objective information to study the formation process of cancer cell colonies.

Keywords - Cancer cell colonies, Optical coherence microscopy, 3D cell culture, microfluidics

Paper ID : B3P-B-15 (#1035)

Highly Selective and Sensitive Gas Sensors for Exhaled Breath Analysis Using CuBr Thin Film.....337

Satoru Momose, Kazuaki Karasawa, Michio Ushigome, Ryozo Takasu, Osamu Tsuboi
Fujitsu Laboratories Ltd., Japan

We report a p-type semiconductor CuBr thin film for a gas sensor indicates ppb order of gas sensitivity. The CuBr film is a candidate for bio-molecular recognition, owing to its exceptionally high selectivity to ammonia or aldehyde, which realizes exhaled breath analysis applications.

Keywords - gas sensor, bio-molecule, ammonia, nonanal, breath diagnostics

Paper ID : B3P-B-16 (#1078)

Robust Multi-Parameter Sensing Probe for Water Monitoring Based on ALD-Coated Metallic Micro-Patterns.....342

Ferdous Shaun{1}, Massimo Pellegrino{1}, William Cesar{1}, Frédéric Marty{1}, Zhifei Xu{1}, Martine Capo-Chichi{1}, Philippe Basset{1}, Bérengère Lebental{2}, Tarik Bourouina{1}
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We report on a multi-sensing probe for water network monitoring enabling simultaneous measurements of water electrical conductivity, flow-rate and temperature. A very simple fabrication process is used where all physical sensors are obtained only from micro-patterning of glass, combining platinum, gold. Further coating using Atomic Layer Deposition (ALD) is achieved for the purpose of reducing both electro-erosion and biofouling, while keeping the sensor's electrical and thermal functionalities. This is critical for long-term reliability of sensors immersed in water. The lateral size of each sensing elements does not exceed a few 100µm. This small footprint allowed implementing a redundancy strategy on the chip, not only for reliability purposes but also to accommodate for different measurement ranges based on scalable designs.

Keywords - multi-sensor, water, Atomic Layer Deposution (ALD)

Paper ID : B3P-B-17 (#1097)

Various Polymers-Coated on Surface Acoustic Wave Array for Detecting Biological Waste Gas Mixture.....N/A

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Use of biological wastes to produce energy has proven to be a practical and economical method it's come from domestic, agricultural even in industrial waste. Biogas can be produced by anaerobic digestion is primarily methane (CH_4), ammonia(NH_3) and moisture. Biogas are mostly similar to natural gas with an additional risk, it can cause an explosion or damage the crops. Surface acoustic wave (SAW) sensor is known as mass loading effect with high sensitivity. In this paper, different polymers are used including PNVP, P4VPy and PS were spin coated on detection zone of SAW sensor based on 128° YX-$LiNbO_3$ to detect moisture, NH_3 and CH_4. Sensors can detect relative humidity (RH) ranging from 40% to 70% and found frequency change on three polymers. The responses of non-coated SAW had good stability and the detection results of different concentration ammonia and methane gas are displayed respectively. Also the measurement for limit of detection of three polymers on NH_3 and CH_4 were tested. After understanding the sensitivity of three polymers respectively choose PNVP to detect mixture gas(NH_3+CH_4), frequency shift was accumulate.

Keywords - Mixture gas, $LiNbO_3$, Surface acoustic wave

Paper ID : B3P-B-18 (#1186)

Characterization of the Local Field Potential in Vitro Cell Network Using Extracellular Recordings.....N/A

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The local field potential (LFP) of the different neurons by cell network cultured on multi-microelectrode arrays (MEA) was explored. A 16-channel detection meter for extracellular signal recording in vitro was used. The neurons recorded contain two kinds: the principal pyramidal cells and fast-firing interneurons. The principal cells with excitatory activity and interneurons with suppressed activity contribute differently to nerve signal transduction and integration, the classification and identification of neurons is important for neural information research. The firing rate of pyramidal cells was less than 1Hz and the firing rate of interneurons was higher than 6Hz in this recording. The local field potential (LFP) of cell network with firing of principal cells had fluctuations (100~1500 10-6V), while the local field potential (LFP) of cell network with firing of interneurons only had small amplitude fluctuations (10~100 10-6V). The LFP of adjacent channels often affected by the firing of the action potential (AP), and a certain level of LFP fluctuations can be observed. The principal cells and interneurons have different expression and opposite activity, the identification and classification of extracellular recorded neurons is significant for the study on the nerve signal transmission and integration of cellular networks.

Keywords - The local field potential (LFP), neurons, cell network, multi-microelectrode arrays (MEA), the firing rate, action potential.

Paper ID : B3P-B-19 (#1067)

Capillary Number Effect on the Depletion of Leucocytes of Blood in Microfiltration Chips for the Isolation of Circulating Tumor Cells.....346

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To increase the purity of isolated circulating tumor cells (CTCs) in microfiltration chips, the depletion of leucocytes in human blood was systematically studied as a function of two dimensionless parameters, Capillary number Ca and the normalized leucocyte diameter. An optimized Ca* of 0.038 was identified to differentiate the capturing of cancer cells and leucocytes. Such Ca effect can be applied as a guideline for designing an optimized microfiltration system with both high capture efficiency and purity for isolating CTCs from human blood.

Keywords - circulating tumor cells, CTC, Capillary number, leucocyte, microfiltration

Paper ID : B3P-B-20 (#1099)

A Simple Strategy of Dielectrophoresis for Capturing Cells with High Purity in the Affinity-Based Microfluidic Chips.....N/A

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The isolation and capture of cells have numerous challenges, especially, the low purity of capturing cells from a host of impurity cells. In this paper, we study an effect of dielectrophoresis (DEP) on the purity of capturing cells in the affinity-based microfluidic chip. The DEP force is introduced by an array of interdigitated electrodes to overcome the non-specific binding forces for non-target cells with little influent of specific binding forces between bio-molecules for target cells. The non-target cells can be pulled away from the capturing sites and target cells can stay in channels, so that the captured purity can be increased. To demonstrate this principle, HCT-116 cells were captured from binary cells samples with CCRF-CEM cells in the affinity-based microfluidic chip. By optimizing the magnitude of the applied alternating current (AC) signals, as well as the dimensions of the electrodes, the purity of the captured HCT-116 cells can be increased from 58% to 95.5%.

Keywords - dielectrophoresis, cells capture, purity

Paper ID : B3P-B-21 (#1159)

Impact of Surface Chemistry on Marangoni Flows Generated by Localized Plasmon Resonance.....N/A

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We present an investigation into the effect of surface chemistry on the nature of Marangoni flows at micron scale bubbles. Bubbles are generated by evaporation of water via localized plasmon resonance in Au nanoparticle (NP) films. By coating nanoparticle films, and supporting substrates, with self assembled monolayers (SAMs) we gain a means to control interactions between the films/substrates, bubbles, and flow fluid. The hydrophobicity of SAMs, as measured by water contact angle, can be adjusted by vacuum ultraviolet patterning and is shown to significantly impact the nature of observed Marangoni flows.

Keywords - photothermal effects, Marangoni flow, self assembled monolayers, wettability

Paper ID : B3P-B-22 (#1277)

Formation and Characterization of Embryonic Stem Cell Aggregates in a Microdevice Platform.....N/A

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Conventional hanging drop technique is the most widely used method for culturing embryonic stem cell aggregates (ES) for embryonic body (EB) formation. However, this method is labor intensive and limited by the difficulty in exchanging medium. To overcome the above limitations, we have developed microdevice which can simultaneously form large numbers of hanging drops for EB formation. Our device also allows for medium exchange, making it possible to continently characterize of cultured EBs on device

Keywords - microfluidics, stem cell, lab-on-a-chip

Paper ID : B3P-B-23 (#1283)

Comparison and Optimization of Blood Filtration Microfluidic Devices.....N/A

Ruba Khnouf, Maram Abdelhadi
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This paper presents several designs of filter-free microfluidic devices for the filtration of red blood cells from blood samples. Two main designs were used; the first design is based on micromachining trenches in the microfluidic devices while the second depends on the blood cell separation in microflows. We have found that the first design is more results in greater plasma extraction however the experimental duration is much longer than the second design.

Keywords - microfluidic device, point of care diagnostics, blood filtrations, sedimentation, blood cell separation

Paper ID : B3P-B-24 (#1309)

Study of the Nutrition Dependency of Microtumor Growth by Using a Microfluidic Platform.....N/A

Carina Jean-Tien Lee, Wei-Wen Liu, Pai-Chi Li, Yu-Hsiang Hsu
National Taiwan University, Taiwan

In this paper, we present a microfluidic model system for the study of the dependency of nutrition supply during the development of a microtumor. Considering the course of tumor development found in vivo, blood supply is usually not involved at early stage. Since the diffusion limit of a living tissue from a capillary network is usually 100 μm long, we designed a microfluidic model system to control the level of nutrition supply in a mm-sized 3D cell construct to study the contribution of nutrition supply. We hypothesized that the physiological environment could play an important role in tumor development. A nutrition deprived environment could be an environmental factor for the development of a growing tumor. Our experimental results suggested that tumor spheroids could form more quickly under a hyponutrition condition than a nutrition fully supplemented environment. It verifies our hypothesis that a nutrition deprived environment could be an important environmental factor to promote tumor growth.

Keywords - microtumor, microfluidics, hyponutrition, tumor-on-a-chip

Paper ID : B3P-B-25 (#1311)

Capacitive Sensor for Continuous Monitoring of High-Volume Droplet Microfluidic Generation.....350

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This paper presents a capacitive sensor for monitoring parallel microfluidic droplet generation. The great electric permittivity difference between common droplet microfluidic fluids such as air, oil and water (ε oil ~2-3 and ε water ~80.4), allows for accurate detection of water in oil concentration changes. Capacitance variations as big as 20 pF are used to continuously monitor the output of a parallelization system producing 200 μL/min of water in oil emulsions. We also discuss a fabrication process to manufacture these capacitive sensors, which can be integrated in different substrates.

Keywords - Capacitive Sensor, Parallelization, Droplet Microfluidics,

Paper ID : B3P-B-26 (#1314)

A Study of the Incubation of Microbead Agglutination Assays in a Microfluidic System.....354

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This work reports on a quantitative study of the incubation of a microbead-based agglutination assay inside a microfluidic system. In this system, a droplet (1.25μL) consisting of a mixture of functionalized microbeads and analyte is flowed through a 0.51mm internal diameter silicone tube. Hydrodynamic forces alone produce a very efficient mixing of the beads within the droplet. We tested the agglutination at different speeds and show a robust response at the higher range of speeds (150μ - 200μL/min), while also reaching a completion in the agglutination process. At these velocities, a length of 180cm is shown to be sufficient to confidently measure the agglutination assay, which takes between 2.5-3 minutes. This high through- put quantification method has the potential of accelerating the measurements of various types of biomarkers, which can greatly benefit the fields of biology and medicine.

Keywords - Agglutination, Microfluidics, Microbeads, Immunoassay

Paper ID : B3P-B-27 (#1325)

Radio Frequency Feedback Method for Parallelized Droplet Microfluidics.....358

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This paper reports on a radio frequency sensor for the continuous monitoring of uniform droplet generation in parallel microfluidic systems. The monitoring of water in oil droplets is accomplished with the use of microwave resonators that are placed over microfluidic channels. The proposed sensor shows frequencies shifts of 50MHz for only a 5% change in water in oil content. Simulations for sensors with one and two resonators configurations are reported in here. The frequency response for the second configuration was found to be the superposition of the response of the individual resonators. This demonstrates independent frequency responses for each resonator that can be used to monitor two or more microfluidic channels without increasing the number of inputs and outputs needed.

Keywords - Radio Frequency, Droplet Microfluidics, Parallelization, Feedback Systems, Micro Reactors

Paper ID : B3P-B-28 (#1016)

A Flow-Through Electrochemical Sensor with Renewable Copper Modified Electrode for Sensitive Nitrate Detection.....362

Yang Li{2}, Yu Song{2}, Hua Lu{1}, Jizhou Sun{2}, Chao Bian{2}, Jianhua Tong{1}, Shanhong Xia{1}
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a flow-through electrochemical sensor with renewable copper modified working-electrode for sensitive and reproducible nitrate measurement is demonstrated. The flow-through sensor is composed of a detection chamber and a three-electrode-system (Pt-Pt-Ag/AgCl), which was designed and fabricated to implement sensitive and reproducible nitrate detection under a programmed operation protocol. Based on an optimal potential protocol, the continuous renewal of copper sensing material was achieved on the working-electrode surface to ensure each measurement can be performed on a fresh and highly active copper surface, which guaranteed that sensitive and reproducible nitrate detection can be realized for a long period of time. The experimental results reveal that the sensor performed high sensitivity of 1.093 μA/mgL^{-1} for long-term nitrate monitoring within the concentration range from 0 to 12.1 mg L^{-1}.

Keywords - Flow-through sensor, Renewable copper, Nitrate Detection

Paper ID : B3P-B-29 (#1062) Withdraw

Paper ID : B3P-B-30 (#1119)

Mouth Guard Type Biosensor Integrated with Wireless Module for Measuring of Saliva Glucose.....N/A

Takahiro Arakawa, Yusuke Kuroki, Hiroki Nitta, Koji Toma, Kohji Mitsubayashi, Shuhei Takeuchi, Toshiaki Sekita, Shunsuke Minakuchi
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We have developed detachable “Cavitas sensors” into human cavitas sites of oral cavity for non-invasive monitoring of saliva glucose. A salivary biosensor based on the integration of working electrode with an enzyme membrane on a mouth guard was demonstrated. This mouth guard type biosensor was integrated with a glucose sensor and wireless measurement system. The electrodes were formed on the mouth guard surface which made of a polyethylene terephthalate glycol. The Pt working electrode was coated with the glucose oxidase (GOD) membrane. In the investigation of in-vitro characterization, the biosensor showed excellent relationship between the output current and the glucose concentration. In artificial saliva consisting of salts and proteins, the glucose sensor exhibits high-sensitive detection in a range of 5-1000 μmol/L. We demonstrated the capability of the sensor and wireless communication module to characterize an inclusion in oral phantom that imitative structure of human oral cavity. Stable and long-term monitoring using telemetry system was established. The mouth guard biosensor would be useful for real-time and non-invasive method as a novel health care management.

Keywords - Biosensor, glucose, saliva, mouth guard

Paper ID : B3P-B-31 (#1205)

Measurement of the Gap Width of the Slot Die Coater by Using a Shear-Mode Detection Micro-Probe.....N/A

So Ito, Hirotaka Kikuchi, Yuanliu Chen, Yuki Shimizu, Gao Wei
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A micro probe and the coordinate measurement system has been developed for the precision measurement of the gap width of the micrometric slit. To realize the high sensitivity and nanometer-scale resolution of the probing, the method of shear-mode detection has been employed in this study. The probe can detect the interaction force due to the water layer on the measuring surface. In this paper, the effectiveness of the micro-probe for the gap width measurement was investigated.

Keywords - micro-CMM, probe, slot die coating, width, measurement

Paper ID : B3P-B-32 (#1291)

Research of Periodic Amorphous Carbon Composite Films for MEMS IR Source Fabricated by Magnetron Sputtering.....366

Anjie Ming{1}, Weibing Liu{3}, Lingling Li{4}, Xilong Sun{2}, Xuan Zheng{2}, Weibing Wang{1}, Qiulin Tan{3}, Jijun Xiong{3}, Dapeng Chen{1}
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In this work, we present a newly titanium-contained periodic amorphous carbon(a-C) composite films by magnetron sputtering on silicon (100) substrate with low intrinsic stress that can be used in electrical modulation pulsed MEMS infrared (IR) source for NDIR gas sensors. The fabrication results and performance analysis are then carried out.

Keywords - MEMS,amorphous carbon films,infrared source,magnetron sputtering

Paper ID : B3P-B-33 (#1022)

Improvement for Gene Transfection of Bacteria Using Magnetic Attraction.....N/A

Yung-Chiang Chung, Yi-Sheng Chen, Shih-Hao Lin, Bo-Ying Qiu, Cheng-Feng Lin
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We propose cells can be descended using magnetic attraction, which leads to shorter experimental time and higher efficiency. We used an electroporation chip with adjustable electromagnetic field as the experimental platform, and tested Escherichia coli and 6-nm magnetic beads combined with DNA plasmid. The magnetic beads were positively charged and easy to bind to the negatively charged cell membrane of E. coli. The magnetic beads and E. coli could be attracted quickly to the bottom because of the electromagnet and could reduce operational time and enhance transfection efficiency. After electroporating and culturing, we obtained the results for E. coli with drug resistance and calculated the number of colony as the transfection efficiency. The achieved transfection efficiency using magnetic beads was seven-fold higher than that without magnetic bead. The following optimum parameter values were determined: 1.4×10^{14} bead/ml for nano-magnetic bead concentration, 200 Gauss for magnetic flux density, and 40 s for magnetic attraction lasting time. The results will help develop transfection applications for low-descent-velocity cells.

Keywords - magnetic attraction, electroporation, gene transfection, magnetic beads

Paper ID : B3P-B-34 (#1052)

Development of Bionic Invasion Membrane for the Study of Multiple Sclerosis.....370

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Multiple sclerosis (MS) is an autoimmune disease and leads to many inflammations. Cause of this disease is autoreactive T cells invade the blood-brain-barrier and attack the myelin sheath. Traditional treatment is to use immune-suppressant, but it has many side effects. Currently, the most effective treatment of MS is to use Natalizumab. Target molecule of this agent is α4-integrin of T cells. The mechanism is to prevent invasion of activated lymphocytes across the blood-brain-barrier. Transwall systems are often used to investigate cell invasion, but there is no specific protein immobilizing on the isolation membrane of these systems. In this work, we have successfully developed a bionic invasion membrane for the study of MS. Different chemokines were applied to the system for the demonstration of drug screening application. The bionic invasion membrane was a PP/PTEE membrane coated with VCAM-1 protein. Jurkat T cell was used to evaluate the feasibility of using the membrane for the study of MS. Results indicated that the invasion ability of T cells was reduced by VCAM-1 protein. The current work provides bionic invasion membrane for the study of MS in vitro.

Keywords - Multiple sclerosis, Blood-brain-barrier, Biochip, Transwell, Jurkat T cell

Paper ID : B3P-B-35 (#1072)

The Improvement of Signal-to-Noise Ratio by Solid-State Nanopores Using a Salt Gradient.....375

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Solid-state nanopores are widely used as detector to analyze individual unlabeled DNA molecules in solutions. The small scale of nanopores(d<5nm) are of the capability to obtain high signal-to-noise ratio information, but their most drawback is that those kind of nanopores are easily blocked during the molecules thread into the pores. Although the large diameter nanopres are not easily blocked and the fabricating cost is less, it is also hard to achieve efficient signal. In this paper, we find a solution which can enhance the signal-to-noise ratio for large scale nanopores"when the cis reservoir concentration is fixed at 1 M KCl, amplitude of the current decrease is enhanced with the trans reservoir concentration changing from 1 M to 0.1 M. Besides, the phenomena do not only occur in the translocation of dsDNA, but also in the translocation of BSA. So it is efficient to distinguish different kinds of molecules and enhance the signal-to-noise ratio

Keywords - Solid-state nanopores, Signal-to-noise ratio, Single molecule detection, Salt concentration gradient

Paper ID : B3P-B-36 (#1235) Withdraw

Paper ID : B3P-B-37 (#1320)

Transparent Thin Film Transistor Electrode Array for Real-Time Electrical Impedance Spectroscopy of Cell Cultures.....379

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We present the usage of an optically transparent Thin Film Transistor (TFT) electrode array to perform arbitrarily spatially confined electrical characterizations of a cell culture. Electrical characterizations allow one to detect not only changes of concentration in cell cultures, but also the components and state of the cells in the culture. Unfortunately these characterizations are dependent on the positioning of the cell and as such require specialized conditions or trapping mechanisms to function. By utilizing a large TFT electrode array we are able to get around this by providing a stochastic aggregate throughout the array that provides consistent metrics for the culture. It has been verified that this device is capable of electrically detecting changes in the living and dead cell concentration in a yeast (S. Cerevisiae) culture.

Keywords - TFT EIS Culture

Paper ID : B3P-B-38 (#1348)

Highly Fluorescent Green Carbon Dots as Theranostic Carriers.....N/A

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In recent years, carbon dots (Cdots) have emerged as a novel platform of fluorescent nanomaterials. These carbon nanoparticles have great potential in biomedical applications in imaging as a result of their unique features such as excellent photoluminescence properties, chemical inertness and low cytotoxicity in comparison to widely used semiconductor quantum dots. However, it remains a great challenge to prepare highly stable, water-soluble green luminescent Cdots with a high quantum yield. The aim of this study is to report the synthesis of green fluorescent Cdots imbuing these desirable properties and demonstrate their potential in biomedical applications. We further assembled our Cdots into nanocomplexes for potential use as theranostic carriers. After confirming that the Cdot nanocomplexes exhibited negligible cytotoxicity with H1299 lung cancer cells, in vitro bioimaging of the Cdots and nanocomplexes was carried out. Doxorubicin (Dox), an anticancer drug, was also loaded into the nanocomplexes and the cytotoxicity effect of Dox loaded nanocomplexes with H1299 lung cancer cells was evaluated. Thus, this work demonstrates the great potential of the novel Cdots in bioimaging and as theranostic carriers.

Keywords - theranostics, carbon dots, fluorescent imaging, chemotherapy

Paper ID : B3P-B-39 (#1064)

The Fabrication of Uniform Silicon Nanopore Arrays.....N/A

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This paper presents an improved wet etching method for the massive production of uniform silicon nanopore arrays. The shape of the nanopores can be easily tuned by changing the length-width ratio of the wet etching masks. Square and rectangular nanopores with different sizes down to 45 nm were controllably fabricated. The relative size error of the nanopores within an 11×11 array was about 10%, which approached the uniformity of nanopore arrays fabricated by electron-beam lithography-assisted reactive ion etching. Using the nanopore arrays as templates of nanostencil lithography, surface micro and nano pattern arrays with good uniformity can be directly deposited on any substrates with less time and low cost.

Keywords - Nanopore array, Silicon, Wet etching, Nanostencil lithography

Paper ID : B3P-B-40 (#1108)

Thermal-Mechanical Reliability Analysis of Connection Structure Between Redistribution Layer and TSV for MEMS Packaging.....384

Wei Meng, Qinghua Zeng, Yong Guan, Jing Chen, Yufeng Jin
Peking University, China

This paper proposes a combination of annular copper and cylindrical copper as the TSV conductor to decrease the impact of TSV expansion in MEMS packaging, which results in a reliability risk between redistribution layer (RDL) and TSV. There are two important factors which may have the most serious influence on the reliability being simulated and analyzed. They are the opening diameter of RDL in SiO_2 and the thickness of cylindrical copper at the bottom of TSV. It is significant to get the optimum structure parameters which can reduce the effect of the risky connection structure on the package reliability obviously.

Keywords - MEMS packaging, reliability, RDL opening, copper thickness

Paper ID : B3P-B-41 (#1138)

Electrical Evaluation of High-Aspect-Ratio Wires Formed by Capillary-Effect-Based Screen-Printing.....388

Ryohei Hokari, Kazuma Kurihara, Naoki Takada, Junichi Matsumoto, Sohei Matsumoto, Hiroshi Hiroshima
National Institute of Advanced Industrial Science and Technology, Japan

In the advancement of printed electronics industry, the development of screen-printing techniques in order to form finer wires with a higher aspect ratio is an important task. To this end, we propose a new concept of screen printing that consists of a combination of the screen-printing process with an imprinting technique, and electrically evaluate the wires. We show that fine and high-aspect-ratio wires are realized by the capillary force of parallel-walled structures (PWSs) on flexible films. A printed wire with a line width of 8.4 μm and an aspect ratio of 7.9 is obtained. Moreover, the electric resistances of the wires formed by the proposed process keep low values compared with the increasing trend of resistance by the conventional process. Furthermore, we expect that this screen-printing process can be applied to obtain submicron patterns as well as more complex patterns by well-designed microstructures.

Keywords - screen printing, imprinting technique, capillary effect, high-aspect-ratio wire, printed electronics

Paper ID : B3P-B-42 (#1163)

Breath Figure Patterns Prepared by Spraying Ultrasonic Atomized Water Droplets.....392

Pengfei Zhang, Huawei Chen, Liwen Zhang, Tong Ran, Deyuan Zhang
Beihang University, China

Honeycomb-structured porous films have widely potential applications in chemical sensors, tissue engineering, micro reactors, catalysis and so forth. An enhanced breath figure method with spraying ultrasonic atomized water droplets replacing the water vapor in humidity is proposed to fabricate multi-level and large-area breath figure patterns (BFPs). Well-defined polyphenylene oxide honeycomb films were prepared at a proper spraying time. The pore size and the regularity of the hexagonal arrays could be regulated by changing the spraying flux and solution concentration. Especially, honeycomb films with two-level pores were fabricated by spraying atomized water droplets two times. Moreover, large-area BFPs with film area larger than 100 cm^2 could be formed on the glass substrate. The large-area BFPs formation capability of the enhanced BFM in this work give new insight into more widely application in surface engineering. For example, slippery lubricant-infused porous surfaces (SLIPS) were prepared using the large-area BFPs as the holding structure. And the prepared SLIPS showed extremely low critical sliding angles for varieties of liquids, and also demonstrated efficient self-cleaning properties and excellent transparency.

Keywords - breath figure patterns, honeycomb films, self-assembly, slippery lubricant-infused porous surfaces

Paper ID : B3P-B-43 (#1165)

Development of High-Performance Parallel Exposure I-Line UV Light Source.....396

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UV light source and high-pressure mercury lamps are usually used as a projecting light source of foreign exposure light source recently, including a spherical mirror ellipse, an optical integrator, and a parallel lens. The light source system is the most crucial technology to achieve better image quality and better uniformity of light field. High-stability, high-uniformity, and high-parallelism light source should be created to ensure the stability of all processes. In this research, two sets of Fly's eye lens are used as an optical integrator for combining with the redesigned parallel lens, which are evaporated AR coating to increase the transmittance of overall optical system up to 80% and the uniformity of light field. Equivalent doublets are also proposed to improve the original design of single parallel lenses for reducing the thickness, curvature, and divergent angle of a single lens so as to enhance the efficiency of light irradiation.

Keywords - Exposure light source, Spherical mirror ellipse, Fly's eye lens, I-line AR coating

Paper ID : B3P-B-44 (#1206)

Synthesis and Evaluation of Thick Bismuth Telluride and Antimony Telluride Films.....N/A

Nguyen Huu Trung, Kei Sakamoto, Nguyen Van Toan, Takahito Ono
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This paper presents the synthesis and evaluation of thick thermoelectric films toward applications of flexible thermoelectric power generators. N-type Bismuth Telluride (Bi_2Te_3) and P-type Antimony Telluride (Sb_2Te_3) films of approximately 100 μm in thickness are successfully synthesized by an electrochemical method and their properties have been evaluated. The Seebeck coefficients of Bi_2Te_3 and Sb_2Te_3 are 161±20 μV/K and 193.5±20 μV/K, respectively. Additionally, the electrical resistivity of Bi_2Te_3 showed 15±5 μΩm. This value is 25±10 μΩm for Sb_2Te_3. The Power Factors of each thermoelectric material can reach 22.5x10-4 W/mK2 for N type (Bi_2Te_3) and 7.3x10-4 W/mK2 for P type (Sb_2Te_3).

Keywords - Thermoelectric materials, electrochemical deposition, pulsed deposition, annealling effects.

Paper ID : B3P-B-45 (#1238)

Fabrication of a Multilayer Spiral Coil by Selective Bonding, Debonding and MEMS Technologies.....401

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For the further miniaturization of integrated circuits, the integration of passive components on the chip is one approach. In DC-DC converter applications, the integration of the inductor with high inductivity is one problem. This paper addresses this problem by proposing a new technique for fabricating a multilayer spiral coil that is also useful as part of electromagnetic MEMS (Micro-Electro-Mechanical Systems) actuators. The multilayer coil is made by stacking separately fabricated coil layers and joining them with a selective bonding and debonding technique.

Keywords - multilayer inductor, monolithic DC-DC converter, VLSI, die-to-wafer bonding, selective debonding

Paper ID : B3P-B-46 (#1253)

Electroplating of Neodymium Iron Alloys.....405

Florian Kurth{1}, Joerg Froemel{2}, Shuji Tanaka{2}, Masayoshi Esashi{2}, Thomas Gessner{1}
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Aim of this work is to make neodymium iron alloys available for MEMS process by electro plating used for permanent magnetic material. Because of the low electro chemical potential of neodymium, three different deposition methods were investigated: Electro plating from aqueous solvent, from non-aqueous solvent and molecular plating. All results shows as brittle deposited film. Due the high oxidation behavior of neodymium a high amount of oxygen could be observed, which indicate a complete oxidized film.

Keywords - Electro deposition, Magnetic materials, thin layers, Neodymium, Magnetic alloys

Paper ID : B3P-B-47 (#1282)

Polydimethyl Siloxane Microfluidic Channel Protein Functionalization Techniques.....409

Ruba Khnouf, Dina Karasneh
Jordan University of Science and Technology, Jordan

Polydimethylsiloxane (PDMS) is one of the most used polymers in the fabrication of lab-on-chip or microfluidic devices. Because of protein binding many applications in microfluidics we have evaluated a number of processes that have been developed to bind protein to PDMS surfaces which include passive adsorption, passive adsorption with Glutaraldehyde cross-linking, APTES functionalization followed by Glutaraldehyde or 1-ethyl-3- (3-dimethylaminopropyl) carbodiimide hydrochloride) (EDC) cross linkers. It has been shown that the latter technique "using EDC- results in more than twice the bonding of protein to the surface of PDMS microchannels than proteins binding passively. We have also demonstrated the effect of PDMS curing methodology on protein adsorption to its surface, and showed that increased curing time is the factor that reduces passive adsorption the most. Finally, we have shown that protein concentration in solution is only a determining factor at low concentrations and that increased protein incubation time during treatment increases binding strength.

Keywords - microfluidic device, polydimethyl siloxane, surface functionalization, surface modification

Paper ID : B3P-B-48 (#1310)

High Performance Reformer for the Partial Oxidation of Methanol by Gradient Concentration of Catalysts.....N/A

Chun Liu, Fan-Gang Tseng
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In this work, we propose the theory of gradient concentration of catalysts distribution among partial oxidation of methanol (POM) reformer. Cu/Mn/Zn catalysts is loaded on copper foams with different pore sizes, and the amounts of catalysts on each copper foam are controlled due to suggestion from simulation. Each copper foam with different amounts of catalysts are placed in corresponding positions among the channel in the reformer. Simulation results show the reformer's temperature uniformity and methanol conversion, and the experiment results show the comparison of the life performance between the reformers with and without gradient concentration of catalysts.

Keywords - reformer, partial oxidation of methanol, hot spot, gradient concentration of catalyst

Paper ID : B3P-B-49 (#1315) Withdraw

Paper ID : B3P-B-50 (#1125)

Fabrication of a Hermetic CMUT Using Hybrid Wafer Bonding Technology.....N/A

Jing Miao{2}, Wenjiang Shen{2}, Jinglong Song{1}, Chenyang Xue{1}, Jijun Xiong{1}
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Capacitive micromachined ultrasonic transducer (CMUT) can be seen in widely applications for next-generation ultrasound technology. In this work, a new fabrication process based on hybrid wafer bonding technology for CMUT is developed for the first time. As a combination of anodic bonding and Au-Au thermal compression boning, the hybrid wafer bonding technology has advantages in high bond strength and low temperature compatibility. Meanwhile, the technical difficulties in cavity vacuum seal, electrical pad extraction can be addressed with this simple and fast proposed approach. Since target imaging test in a water tank, the fabricated device provides great potential for immersion imaging applications.

Keywords - CMUT, hybrid wafer bonding, hermetic

Paper ID : B3P-B-51 (#1160)

Feasibility Study of System Design and Elemental Technologies for Consumer-Use Ingestible Sensor Platform Utilizing Gastric Acid Battery.....N/A

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In this study, we have proposed an ingestible sensor platform utilizing gastric acid battery for daily healthcare. This sensor platform has the capability to precisely measure basal body temperature (BBT) during the hours of sleep as one of the most useful vital signs, and has the expandability for addition of various biosensors such as pH sensor etc.. The generated electric power due to a galvanic effect utilizing gastric acid is stored to a capacitor, and consumed for the device operation even since stomach. The measured data is coded and transmitted to an extracorporeal receiver by magnetic resonance coupling communication technique. This paper reports on the feasibility study of the proposed system and key technical elements.

Keywords - Ingestible sensor, Gastric acid battery, Basal body temperature

Paper ID : B3P-B-52 (#1168)

Omnidirectional Acceleration Sensor for Trigger of Human Monitoring System.....N/A

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In order to realize a human health monitoring system with ultra-low power consumption, several modes including sleep mode should be selected according to proper situations. Vibration intensity, indicating activity level of the human, can serve as a useful trigger for the mode selection of the system. In this work an omnidirectional acceleration sensor, which has “omnitensile” structure combined with series-connected piezoelectric elements is proposed for the trigger. The series-connected piezoelectric elements can multiply output voltage. The elements generate a unipolar signal independent from the direction of the acceleration because the proposed “omnitensile” structure is always subjected to tensile stress when acceleration is applied to the device. From finite element analyses, the device dimensions are optimized. In addition, the output voltage is estimated beyond 0.88 V/G independent from the direction of the acceleration. The output voltage can be free from power-consuming circuits. A zero-power-consumption MEMS trigger can be realized.

Keywords - MEMS Accelerometer, Piezoelectric PZT, Omni-directional, Trigger, Human health monitoring system

Paper ID : B3P-B-53 (#1243)

Design Optimization of Integrated Shear Strain Gauge for Single-Crystal-Silicon Parallel Tensile-Testing Device.....N/A

Kanji Yasuda, Akio Uesugi, Yoshikazu Hirai, Toshiyuki Tsuchiya, Osamu Tabata
Kyoto University, Japan

In this paper, design optimization of a share strain gauge integrated in a newly developed parallel tensile testing device is reported. The testing device has been developed to investigate the tensile-mode fatigue properties of single crystal silicon microstructures with high throughput. The share strain gauge is adopted instead of a tensile strain gauge used in the previous report in order to increase the stiffness and sensitivity for higher loading frequency of the device. The beams angle of shear strain gauge with respect to the tensile axis was optimized to get a maximum resistance change with keeping the device stiffness high. The maximum sensitivity was obtained at 14° and 15° tilting from the orthogonal axis in p-type and n-type silicon, respectively.

Keywords - Tensile Testing, Integrated Strain Gauge, Single Crystal Silicon

Paper ID : B3P-B-54 (#1353)

A Design of Spring Constant Arranged for MEMS Accelerometer by Multi-Layer Metal Technology.....419

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We report an approach to design spring constant arranged for MEMS accelerometers fabricated by multi-layer metal technology. The proposed multi-layer metal structure can control the spring constant of serpentine flexure to suspend high-density proof mass. Moreover, the multi-layer metal configuration enables us to obtain high degree of freedom of spring constant design without compromising the performance of the MEMS accelerometer. A proof-of-concept device has been fabricated, and the measured characteristics of the proposed micromechanical springs were consistent with the design values.

Keywords - Spring constant, MEMS, acceleroemter, multi-layer metal, serpentine, high-density proof mass

Paper ID : B3P-B-55 (#1199)

Stylus Type MEMS Texture Sensor Covered with a Corrugated Diaphragm.....N/A

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we present a stylus type mems texture sensor covered with a corrugated palylene diaphragm, which protects the surface of the sensor but does not significantly degrade sensitivity or bandwidth. a new fabrication process for bonding the diaphragm to a 3-axis piezoresistive force sensor at wafer level has been developed, and the proposed texture sensor has been fabricated, and the surface roughness and friction coefficient were successfully detected.

Keywords - mems texture sensor, piezoresistor, parylene-c, corrugated diaphragm, roughness, friction coefficient

Paper ID: B3P-B-56 (#1169)

Canal-Type Artificial Lateral Line Sensor Array Based on Highly Aligned P(VDF-TrFE) Nanofibers.....423

Longlong Gong, Jianchao Fu, Zhiqiang Ma, Deyuan Zhang, Yonggang Jiang
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We present a canal-type artificial lateral line (CALL) sensor array that utilizes highly aligned P(VDF-TrFE) nanofibers as the primary sensing material. The design of CALL structure is inspired by the lateral line system of fish, in which highly aligned P(VDF-TrFE) nanofibers are employed as the artificial neuromasts for hydraulic pressure sensing. We improved the traditional far-field electrospinning process and fabricated freestanding architectures with aligned arrangements of P(VDF-TrFE) nanofibers. Both of Fourier transform infrared (FTIR) spectra and X-ray diffraction (XRD) patterns show that such nanofibers have formed polar β-phase. This highly aligned piezoelectric nanofibers offer exceptional piezoelectric response to enhance the sensitivity of the CALL sensor array. The differential output of the artificial neuromast is demonstrated.

Keywords - P(VDF-TrFE), electrospinning, Lateral Line, biomimetic sensor

Paper ID : B3P-B-57 (#1295)

Deposition of Parylene C and Characterization of its Hermeticity for the Encapsulation of MEMS and Medical Devices.....427

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Following the recent trend of miniaturization of MEMS and the approach to improve the comfort of medical implants for patients by reducing their size the polymer Parylene is a promising candidate for the encapsulation. Parylene combines a number of excellent properties like biocompatibility / biostability, chemical inertness, transparency and low water permeability. Within the presented work the deposition characteristics and properties like conformity, permeability of water vapor, etc. are examined.

Keywords - Parylene, CVD, hermeticity, encapsulation, MEMS, medical, packaging

Paper ID : B3P-B-58 (#1341)

Design of CMOS-MEMS Infrared Emitter Arrays.....433

Zhengxi Cheng, Hiroshi Toshiyoshi
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This paper presents a new design of complementary metal-oxide-semiconductor-microelectromechanical systems (CMOS-MEMS) infrared emitter arrays integrated with metamaterial absorbers (MA). The infrared emitter array is a key IR thermal radiation source for gas sensors. The IR emitter arrays are implemented using the standard CSMC 0.5 μm 2P3M CMOS process. Three different shape of micro emitters are designed with 2 different thin film layers stacks, without and with metamaterial absorbers, for each shape. Micro structures are released from Si substrate through the post-CMOS dielectric dry etching and bulk silicon wet etching. Read-in circuit is also integrated with each 8×8 scale emitter array. Steady state thermal responses and dynamic thermal responses are simulated through multi-physics coupling finite element method (FEM), then radiation responses are calculated with a Matlab program based on thermal responses. Emissivity of emitters are also calculated through FEM simulation, which shows that the integration of metamaterial absorbers is an effective way to increases emissivity in both short and long infrared wavebands.

Keywords - infrared, CMOS, MEMS, thermal radiation emitter, IR emitter

Paper ID : B3P-B-59 (#1051)

Theoretical, Numerical and Experimental Study of Residual Stress Effect on Two Microresonators for Acoustic Sensing.....438

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Hong Kong University of Science and Technology, Hong Kong

Residual stress during the micro-fabrication process has been one of the main issues in many MEMS/NEMS sensors and actuators, especially acoustic sensing. We conduct theoretical, numerical and experimental study on the residual stress (RS) effect on the frequency responses of two types of polysilicon micro circular resonators: clamped and RS free design which can release the process-induced stress and is of easy fabrication. The measured natural frequency of the fabricated device is 39.8 kHz, in good agreement with both theoretical and FEM simulation results. We also determined the natural frequencies of these two designs as a function of RS. Under the same experimental RS condition of 50 MPa, the normalized changes of natural frequencies of these two designs are 159.7% versus 0.8%, respectively.

Keywords - microresonator, residual stress, acoustic sensing, natural frequency

Paper ID : B3P-B-60 (#1148)

A Design of TPoS Resonator with Narrow Tether.....446

Xinyi Li, Jingfu Bao, Feihong Bao
University of Electronic Science and Technology of China, China

A novel kind of RF MEMS lateral extensional thin-film piezoelectric-on-silicon(TPoS) resonator with narrow tethers is proposed. The conventional three-layers supporting beams could be simplified to single material by utilizing different kinds of doping on the bulk structural silicon layer. Within the scope of the fabrication process allowed, the width of tethers could be decreased from 10um to 2um, which would greatly reduce the dissipation of the energy from anchors. The finite element analysis simulation results show that the quality factor of the resonator is raised from 13800 to 207300. One feasible way to fabricate this novel resonator is demonstrated. To overcome the disadvantage of power capacity limited by the P-N junction, one associative operating circuit is also introduced.

Keywords - resonator, piezoelectric, anchor loss

Paper ID : B3P-B-61 (#1218)

Electromechanical Fabrication of Conformal Nanogap Electrodes for Thermotunnelling Cooling.....N/A

Amit Banerjee, Yoshikazu Hirai, Toshiyuki Tsuchiya, Osamu Tabata
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Reliability and efficiency of electronic devices are extremely dependent on the efficiency of heat-dissipation. Sensitivity of many sensors also relies on cryogenic environment. Traditional refrigeration techniques are difficult to miniaturize and implement for on chip cooling due to their complicated designs with several moving parts. Thermotunnelling cooling, wherein hot electrons are selectively transported across a nanogap through quantum mechanical emission processes is attempted in this work for futuristic refrigeration technique. We intend to fabricate a MEMS device, which can produce a pair of conformal electrodes for simultaneous large area emission, through a controlled electromechanical fracture process.

Keywords - Mechanical Fracture, Conformal electrodes, Thermotunnelling cooling

Paper ID : B3P-B-62 (#1252)

Modeling of Zero TCF and Maximum Bandwidth Orientation for Lithium Tantalate RF MEMS Resonators.....450

Gayathri Pillai, Wei-Siang Tan, Cheng-Chi Chen, Sheng-Shian Li
National Tsing Hua University, Taiwan

This work presents an elaborate analytical analysis and finite element geometry modeling to investigate the Temperature Coefficient of Frequency (TCF) and bandwidth (BW) for different orientations and modes of operation in Lithium Tantalate (LT) MEMS resonators. Optimum cut algorithm is used to find the ideal wafer orientation and the algorithm is cross-verified using Finite Element Method. Length extension mode resonators operating in the fundamental mode transcend contour mode and thickness extension modes. LT resonators with a wafer orientation of (90°, 41°, 60°) operating in the fundamental length extension mode yield close to zero TCF and when oriented along (90°, 44°, 60°) it provides a maximum BW of 2.67%. Best values of both BW and TCF can be achieved simultaneously in a very close range of wafer orientation.

Keywords - Lithium Tantalate, Temperature Coefficient of Frequency, Bandwidth, Length extension mode, Contour mode, Thickness extension mode, Wafer orientation.

Paper ID : B3P-B-63 (#1508)

A MEMS Piezoelectric in-Plane Resonant Accelerometer with Two-Stage Micro-Leverage Mechanism.....455

Yixiang Wang, Hong Ding, Xianhao Le, Jin Xie
Zhejiang University, China

We firstly present a MEMS (micro-electromechanical systems) piezoelectric in-plane resonant accelerometer with two-stage micro-leverage mechanism. Double ended tuning fork (DETF) resonators are actuated and sensed with aluminum nitride (AlN). The differential sensitivity of the device is 28.4Hz/g, which is higher than the previously reported data.

Keywords - resonant accelerometer, piezoelectric, micro leverage

Paper ID : B3P-B-64 (#1515)

Simulation and Experiment of Inverted Pyramid DBD Micro-Plasma Devices Array for Maskless Nanoscale Etching.....460

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A novel maskless nanoscale material etching method based on microcavities dielectric barrier discharge (DBD) array with advantages of high accuracy and high efficiency has been proposed in this paper. A two-dimensional simulation of pyramidal hollow cathode DBD microplasma operated in Ar has been studied using FEM method. Results indicated that high density microplasma with its magnitude of 1e18/m3 is obtained in microcavity. Total absorbed power enhance as relative permittivity of dielectric layer increased. A 3×3 50 μm inverted pyramidal microplasma array without dielectric layer has been successfully fabricated by MEMS process and discharged stably in 10kPa Ar, which may lay a good foundation of ongoing DBD microplasma devices array and future maskless nanoscale etching.

Keywords - Micro Dielectric Barrier Discharge, Microplasma, MEMS, FEM