IEEE-NEMS 2019

Bangkok, Thailand April 11-14

The 14th Annual IEEE International Conference on

Nano/Micro Engineered and Molecular Systems

PROGRAM

The 14th Annual IEEE International Conference on Nano/Micro Engineered and Molecular Systems

IEEE-NEMS 2019

Conference Digest

Bangkok, Thailand

April 11-14, 2019

IEEE-NEMS 2019 PROCEEDINGS

IEEE Catalog Number:	CFP19NME-ART
ISBN:	978-1-7281-1629-7
IEEE Catalog Number (USB):	CFP19NME-USB
ISBN (USB):	978-1-7281-1628-0

Copyright and Reprint Permission:

The Institute of Electrical and Electronics Engineers, Inc.

Welcome Message

On behalf of the organizing committee, we would like to welcome everybody to the 14th Annual IEEE International Conference on Nano/Micro Engineered and Molecular Systems (IEEE-NEMS 2019)! IEEE-NEMS is a premier conference series established by the IEEE Nanotechnology Council to promote advanced research and development activities in MEMS, nanotechnology, and molecular systems. The first IEEE-NEMS took place in January 2006 in Zhuhai, China; since then, this conference has evolved into a highly-anticipated annual event where engineers, researchers, entrepreneurs, and industry leaders from all over the world share their knowledge of the latest innovations in the rapidly developing field of NEMS. Over the last decade, the host cities for IEEE-NEMS have included Shenzhen (China), Kaohsiung (Taiwan), Hawaii (USA), Sendai (Japan), Los Angeles (USA), and Singapore. In 2019, IEEE-NEMS will be held from April 11 to 14 at the Bangkok Marriott Marquis Queen's Park, Bangkok, Thailand. We are very excited about bringing IEEE-NEMS to the vibrant city of Thailand, known for its world-class universities, high-tech industry, and beautiful weather. It is our sincere hope that you will find your IEEE-NEMS 2019 experience both invigorating and rewarding.

IEEE-NEMS 2019 has received over 250 submissions from various regions and countries around the world. After careful consideration by the technical program committee, 136 papers were selected for regular oral presentations and 67 papers for poster presentations. The regular oral presentations are organized into four parallel tracks in the morning sessions and four to five in the afternoon sessions based on eight specific topic areas, including M/NEMS, Micro/Nano Fluidics, Micro/Nano/Molecular Fabrication, Molecular Sensors, Actuators, and Systems, Nanomaterials, Nanomaterial Based Devices and Systems, Micro/Nano Mechanics and Nanoscale Robotics, and Fluidics, Photonics, and Electromagnetics. Other than the regular presentations, the conference will also feature 7 plenary and 12 keynote talks, as well as 73 invited talks organized into 15 separate sessions with diverse topics ranging from emerging micro- and nanoscale sensing technologies to advanced nanotheranostics.

We would like to thank you, the conference attendees, for traveling to Bangkok during your busy schedule to network and share your unique expertise with the NEMS community. We hope IEEE-NEMS 2019 will an intellectually stimulating conference for you, and you will also enjoy the exceptional cultural experience during your trip to Bangkok!

General Chair
Yufeng Jin
Peking University

General Co-Chair
Wen Jung Li
City University of Hong Kong

General Co-Chair
Jeffery Yao
National Tsing Hua University

Program Chair
Cecil Chen
City University of Hong Kong

NEMS 2019 Conference Committees

International Advisor Committee

Tzyh-Jong Tarn	Washington University (Chair)
Chih-Ming Ho	University of California at Los Angeles
Masayoshi Esashi	Tohoku University
Meyya Meyyappan	NASA AMES
Nicolas F. de Rooij	University of Neuchatel
Toshio Fukuda	Beijing Institute of Technology / Meijo University

Steering Committee

Ning Xi	The University of Hong Kong (Chair)
Alice H. X. Zhang	Peking University
Daoheng Sun	Xiamen University
Gwo-Bin Vincent Lee	National Tsing Hua University
Osamu Tabata	Kyoto University
Wen Jung Li	City University of Hong Kong
William C. Tang	University of California, Irvine
Shuji Tanaka	Tohoku University
Yu-Chong Tai	California Institute of Technology

General Chair

Yufeng Jin	Peking University

General Co-Chairs

Wen Jung Li	City University of Hong Kong
Jeffrey Dajeng Yao	National Tsing Hua University

Program Chair

Cecil T.-H. Chen	City University of Hong Kong

Program Co-Chair

Zhan Yang	Soochow University

Organizing Chair

Adisorn Tuantranont	NECTEC

Organizing Co-Chair:

Wibool Piyawattanametha	King Mongkut's Institute of Technology Ladkrabang

Special Invited Sessions Committee Chair

King W. C. Lai	City University of Hong Kong

Members

Thomas K. F. Lei	Chang Gung University
Na Liu	Shanghai University

Award Committee Chair

Jin-Woo Kim	University of Arkansas

Members

Aaron H. Ohta	University of Hawaii
Guangyi Shi	Peking University
Steve C. H. Tung	University of Arkansas

Publication Chair:
Zhidong Wang — Chiba Institute of Technology

Finance Chair
Yuliang Zhou — Northeast University at Qinhuangdao

Conference Secretary
Cong Wu — City University of Hong Kong

Technical Program Committee

Mahmoud Almasri
Kean Aw
Victor J. Cadarso
Chia-Hung Chen
Ting-Hsuan Chen
Weiqiang Chen
Pei-Yu Chiou
Chang-Hwan Choi
Cheng Hsin Chuang
Han-Sheng Chuang
Bo Cui
Liang Dong
Shih-Kang Fan
Yu-Jui Fan
Maurizio Rosario Gullo
Yoshikazu Hirai
Walter Hu
Nien-Tsu Huang
Tony Huang
Kuo-Yung Hung
Kentaro Kawai
Takeshi Kobayashi
Hiroyuki Kudo
King Lai
Raymond H. W. Lam
Choongyeop Lee
Gwo-Bin Lee
Sang-Seok Lee
Kin Fong Lei
Thierry Leichle
Tie Li
Wen Li
Wen Jung Li
Peter Lillehoj
Che-Hsin Lin
Chih-Ting Lin
Qiao Lin
Yen-Heng Lin
Yu-Sheng Lin
Cheng-Hsien Liu
Huicong Liu
Shiyuan Liu
Yen-Wen Lu
Leidong Mao
Massimo Mastrangeli
Hyejin Moon
Frank Niklaus
Sung-Yong Park
Tingrui Pan
Prosenjit Sen
Xuechuan Shan
Wenjiang Shen
Yantao Shen
Aimin Song
Koji Sugano
Litao Sun
Yubing Sun
Takaaki Suzuki
Fan-Gang Tseng
Toshiyuki Tsuchiya
Hideaki Tsutsui
Steve Tung
Luis Guillermo Vilanueva
Dong F. Wang
Wei Wang
Zenghui Wang
Zhidong Wang
Zheyao Wang
Pak Kin Wong
Tak Sing Wong
Angela Wu
Jin Xie
Huikai Xie
Bin Yang
Lung-Jieh Yang
Zhan Yang
Jeffrey Yao
Kwang-Seok Yun
Feng-Yuan Zhang
Guanglie Zhang
Hai Xia (Alice) Zhang
Xiaojing (John) Zhang
Xiaosheng Zhang
Yi Zhang
Guangya Zhou

NEMS 2019 Sponsors

We acknowledge the support of the following Sponsors to the 14th IEEE International Conference on Nano/Micro Engineered and Molecular Systems.

IEEE

Nanotechnology Council

Peking University

City University of Hong Kong

National Tsing Hua University

Soochow University

National Key Laboratory of Science and Technology on Micro/Nano Fabrication

American Elements

Micromachines

General Information

Bangkok Marriott Marquis Queen's Park

Address: 199 Sukhumvit Road Soi 22, Khlongton, Khlongtoei, Bangkok 10110, Thailand

Registration Desk:

Date		Time	Venue
April 11	Thu	14:00-18:00	Concierge, Lobby
April 12	Fri	08:30-18:00	Pre-function Area, 2/F
April 13	Sat	08:30-16:30	Pre-function Area, 2/F
April 14	Sun	08:30-18:00	Pre-function Area, 2/F

Conference Events:

Welcome Reception on April 11

18:00-20:00 at Pool House, 4/F

Conference Lunches on April 12-14

(April 12) 12:40-14:00 at Goji Kitchen & Bar, Lobby

(April 13) 12:40-14:00 at Sala Thai Ballroom, 5/F

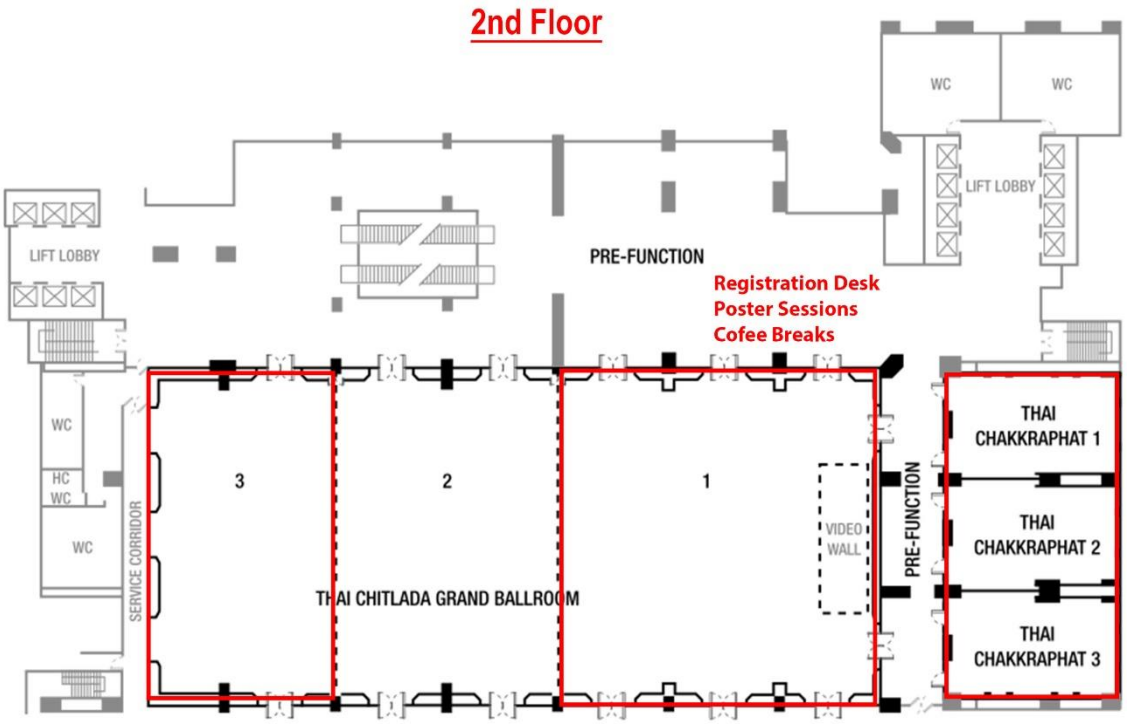
(April 14) 12:40-14:00 at Sala Thai Ballroom, 5/F

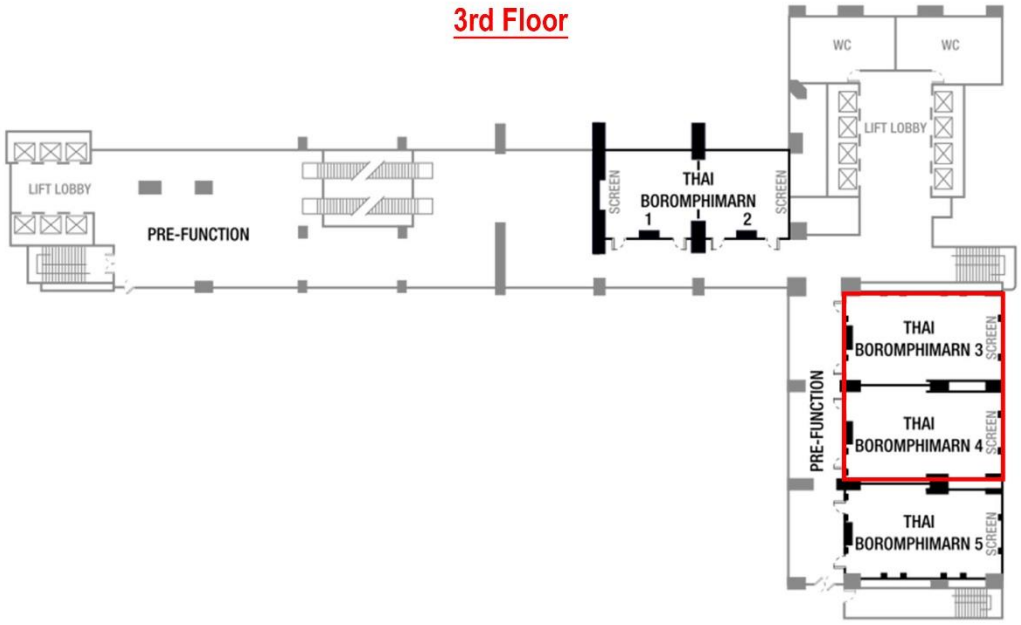
Farewell Party on April 14

18:00-20:00 at Thai Chitlada Ballroom 3, 2/F

For the welcome reception, conference lunches and farewell party, all registered participants are free.

Floor Map


2nd Floor
WC
WC
LIFT LOBBY
LIFT LOBBY
PRE-FUNCTION
Registration Desk
Poster Sessions
Cofee Breaks
WC
HC
WC
WC
SERVICE CORRIDOR
3
2
1
VIDEO WALL
PRE-FUNCTION
THAI CHITLADA GRAND BALLROOM
THAI CHAKKRAPHAT 1
THAI CHAKKRAPHAT 2
THAI CHAKKRAPHAT 3


3rd Floor
WC
WC
LIFT LOBBY
LIFT LOBBY
PRE-FUNCTION
SCREEN
THAI BOROMPHIMARN 1
2
SCREEN
PRE-FUNCTION
THAI BOROMPHIMARN 3
SCREEN
THAI BOROMPHIMARN 4
SCREEN
THAI BOROMPHIMARN 5
SCREEN

Official Language

The official language of the conference is English.

All presentation including discussion and submissions shall be made in English.

Presentation Specifications

In each oral presentation room, one LCD projector will be available. The presenters should prepare Power Point Slides to facilitate their presentations. NO laptop will be provided in each meeting room. The presenters should bring their own laptop and test it before session start to avoid potential format problems caused by different software versions.

Duration for each category of oral presentation are listed below:

- **Plenary Lectures** are scheduled for 35 minutes (including Q&A) each.
- **Keynote Lectures** are schedule for 25 minutes (including Q&A) each.
- **Regular Sessions** are schedule for 15 minutes (including 3 min Q&A) each.

Poster Specifications

Dimensions: A0 Size: 33.1 inches (84.1 cm) wide x 46.8 inches (118.9 cm) high.

Title: The title of your poster should appear at the top with lettering of at least 70 pt font size). Below the title, place the names of authors and their affiliations.

Text: Text should be readable from five feet away. Use a minimum font size of 18 pt. Keep the text brief. Try to use text to introduce the study, explain visuals and direct viewers' attention to significant data trends and relationships portrayed in the visuals, state and explain the interpretations that follow from the data. It is also a good idea to put future research plans or questions for discussion with viewers in your text.

Figures: Each figure should have a brief title. Figures should be numbered consecutively according to the order in which they are first mentioned in the text. Try to use color figures rather than only black and white text to make your poster attractive and highlight the important technical content of your paper. Make sure that the text and the visuals are integrated.

Conference Attire

Appropriate attire is requested during the conference; e.g., casual attire at the Welcome and Farewell Party; a business suit or a white shirt with a neck-tie at all technical sessions.

Conference Awards

Best Conference Paper Award

Any paper with original research results can be considered for the Best Conference Paper Award, provided that the research results presented have not been presented anywhere else in the world at the time of abstract submission.

Best Student Paper Award

Any original research work can be considered for the Best Student Paper Award, provided that the first author is a student and primary developer of the ideas contained in the paper.

CM HO Best Paper Award in Micro/Nano Fluidics

The purpose of this award is to promote the fundamental understanding of micro/nano fluidics phenomena and the application of this technology in molecular detection, manipulation, and in biology and medicine.

Best Conference Poster Award

All accepted poster presentation papers presented at the conference are eligible for the Best Conference Poster Award. The contents presented at the poster sessions should be of original research results.

About Bangkok

In the midst of dynamic modern growth, Bangkok miraculously manages to preserve its cultural heritage to a marked degree. The soaring roofs and gleaming spires of the Grand Palace and the city's many historic temples – Temple of the Emerald Buddha, Temple of Dawn and other evocative shrines – present the visitor with a picture of medieval Oriental wonder; the very stuff of Eastern fairytales. And contained within Bangkok's monuments and sights are treasures of the nation's artistic and cultural endeavor that typify the land and the people. The influence of the past and the enduring threads of the social fabric are not limited to the static. They continue to pervade daily life. Files of saffron-robed monks making their early morning alms round, for example, present an image unaltered in essentials by the passing of time. Today's backdrop of high-rise buildings serve only to emphasize the exotic and timeless scene, while the city draws definition from it. Indeed, there is much to discover, and in addition to the city's most famous monuments there are numerous lesser known sights of great interest. The Chapel of the Emerald Buddha, which enshrines the national palladium, rightly tops the sightseeing list, but Bangkok numbers more than 400 temples, many of which have their own fascination. A similar selection can be made with museums. The National Museum is excellent and comprehensive, but as impressive in their own ways are the Jim Thompson House, Vimanmek Mansion and Suan Pakkad Palace, all of which house fine art collections within noteworthy settings. Not least, cruising the Chao Phraya River and the remaining canals, which once made Bangkok the "Venice of the East" offers a glimpse of traditional riverine lifestyles, affording insights into the history and character of this wondrous city. For more information please visit homepage of the Tourism Authority of Thailand, https://www.tourismthailand.org/

Climate

Thais enjoy a tropical climate with three distinct seasons – summer from March until May, rainy with plenty of sunshine from June until September, and cool from October until February. The average annual temperature in Bangkok is 28°C (82.4°F). Temperature in December is around 25°C (77°F).

Local Time:

GMT + 07:00 hour

Currency

There are 100 Satang in 1 Baht (B). Notes are issued in denominations of B1,000, B500, B100, B50, B20. There are 10, 5, and 1 Baht coins and 50 and 25 Satang. Most foreign currencies and traveler's cheques are easily changed at banks, hotels, or money changers. All major credit cards are widely accepted.

Electricity

The electric system is 220 Volt AC. There are many plugs and sockets available for use in the hotel. Travelers with shavers, computers, and other personal electronics should carry a plug-adapter kit.

Troubles in Thailand

Thailand Tourist Police: Tel: 1155 (free call from any phones) or 678-6800

Regular Police: Tel: 191 or 123 (free call from any phones)

Songkran Festival 2019 (Thai Water Festival)

April 13-15

Songkran Festival is the Thai New Year's Festival which takes place every April. It is also Thailand's biggest and most famous water festival in Thailand. It marks the start of the traditional Thai New Year.

Songkran is derived from a Sanskrit word saṃkrānti which literally translates to "astrological passage" and means 'passing', 'approaching', 'change', or 'transformation'. The official holiday runs from the 13th up to the 15th of April but the festivities may last a week or more.

The traditional way of celebrating the water festival involves Thai people splashing water on their elders, family members, close friends, and neighbors as a way of looking for good fortune. They also visit temples and pay homage to the images of Buddha.

Large and wild crowds fill the streets of Bangkok for the celebration. Khao San Road, a popular area for backpackers, and Silom, the street known for Patpong, are packed with the largest and wildest crowd where thousands of Thais and tourists throw water using water guns, water hoses, or anything that can spray water and get soaked in the middle of a party. There are lots of beer, food, and liquor within those areas.

For the more traditional way of celebrating Songkran, Thais build sand stupas and decorate them with colorful flowers and flags which can be seen around key temples within Rattanokosin. In Phra Phradaeng District, the Thai Raman communities carry on with their traditional Songkran traditions which take place a week later than the celebration in central Bangkok. Enjoy an array of cultural activities such as floral floats parade, Raman dances, 'saba' game, Thai-Raman flag ceremony, boat races, and a whole lot more.

Beauty pageants and food fairs are held in Wisutkasat area.

Tips for Surviving Thailand's Songkran Festival

- Plan ahead and book your accommodation early depending on where you want to celebrate Songkran. Hotels get fully booked during Songkran.
- Play by the rules. Fight with clean water and fight only with water. Do not use ice cubes or other things that can injure other people. You can fight with water guns, cups, buckets, garden hoses, water balloons, etc. Be careful not to hit others on the eyes or other sensitive parts of the body.
- Dress appropriately. You will get soaked in water no matter what. It's not advisable to wear white. Dress up as if you are going to the beach. You can

wear a swimsuit underneath and wear light clothing that can easily dry and will still make you feel comfortable no matter how wet you are.

- Bring a waterproof bag. Put all your valuables and gadgets in a waterproof bag to make sure that they won't get wet. Using a Ziploc is possible.
- Use a waterproof camera. Capture those crazy moments while enjoying all the chaos using a waterproof camera.
- Be prepared to be targeted once you step outside. Just be cool about it. Be prepared and don't complain once you get soaked in water. Beware though of people coming up to you and putting wet powder on your face.
- Avoid swallowing the water to avoid stomach problems.
- Do not ride a car or motorbike to avoid accidents.

Reference: https://expertworldtravel.com/songkran-day-festival/

Plenary Talk 1
Friday, April 12, 2019, 8:50 - 9:25
Thai Chitlada 1, 2/F
Chair: Osamu TABATA, Kyoto University

Mild Methods to Engineer Fragile Materials Micro and Nano Systems

Juergen BRUGGER

Microsystems Laboratory, EPFL,

Swiss Federal Institute of Technology

ABSTRACT

The manufacturing of silicon-based micro/nano-electro-mechanical-systems (MEMS/NEMS) today is well advanced because the devices for automotive, domestic, health-care and consumer electronics can be fabricated with methods from IC industry. Polymer-based systems have a great potential for flexible electronics and biomedical applications, but to date, the techniques to engineer functional, and often fragile, polymers into 3D are still at their beginning because a coherent fabrication platform with the right tools and processes do not yet exist. The field however starts to benefit from increased efforts in various soft and polymer materials applications. Additive manufacturing, (e.g. 3D printing) and associated processing (e.g. sintering) have already started to transform traditional industry. These approaches however are difficult to scale below a micrometer because the thermal processing is either done in bulk using furnaces or on surface using lasers.

This talk will give an overview of recent achievements in advanced manufacturing at the micro/nanoscale and associated key techniques than can be applied in particular to fragile materials, where harsh process steps using charged beams and etch chemistry are harmful. I will in particular present nanostenciling, inkjet printing, capillary self-assembly and local thermal processing. Each of them may form part of the future toolbox with gentle fabrication steps for manufacturing fragile material systems. High-resolution stenciling [1] is a quite old technique, but it keeps allowing us to study new and highly localized material deposition phenomena without the need for high-energy beam exposure and etching or development steps. Examples include metallic nanostructures (< 50nm) on rigid and flexible polyimide, parylene, SU-8 and PDMS substrates for biosensors. More recently the reduced material flux through stencils in PVD allows controlling surface crystallization of molecules for organic electronic [2]. Drop-ondemand printing of functional inks is a wet additive manufacturing approach and has been also demonstrated for SU-8 [3], nanoparticle based inks with multicolor luminescent [4] and with magnetic properties [5]. Capillary assisted assembly is a particularly mild (water based) method to position loads of prefabricated nanostructures from a colloidal solution into a deterministic surface layout, with high yield and a control down to a few nanometer precision on individual position, orientation and interparticle gap [6]. Finally, local thermal processing of functional material with sub-micrometer resolution is a quite new technique based on a thermal scanning probe lithography tool. Besides creating lithography patterns in temperature sensitive resists, we used it to write patterns in temperature responsive polymers, such as topographic/fluorescence motives in supramolecular polymers [7] and into water soluble silk [8]. All these methods are part of a new mild toolbox and have in common that they permit the use of delicate materials to engineer new types of MEMS/NEMS. Upcoming target applications are (biodegradable)

implantable MEMS. They are very challenging to fabricate, but if successful, they also have an enormous impact for future wearables and implantables. The paper will show the advantages and limits of each technique and will provide some guidance how they could be combined in mix-and-match approaches with conventional methods.

REFERENCES

[1] O. Vazquez-Mena, et al. Resistless nanofabrication by stencil lithography: A review, Microelectronic Engineering, 132 (2015) 236-254, and references therein.

[2] P. Fesenko, et al. Growth Of Organic Semiconductor Thin Films With Multi-Micron Domain Size And Fabrication Of Organic Transistors Using A Stencil Nanosieve, ACS Applied Materials and Interfaces (2017)

[3] V. Fakhfouri et al. Drop-On-Demand Inkjet Printing of SU-8 Polymer; Micro and Nanosystems (2009)

[4] E. Binetti et al. Nanotechnology (2012)

[5] L. Jacot-Descombes et al. Inkjet Printing of High Aspect Ratio Superparamagnetic SU-8 Microstructures with Preferential Magnetic Directions, Micromachines. (2014)

[6] V. Flauraud, et al. Nanoscale Topographical Control of Capillary Assembly of Nanoparticles, Nature Nanotechnology (2017)

[7] S. T. Zimmermann et al. Nanopatterning of a Stimuli-Responsive Fluorescent Supramolecular Polymer by Thermal Scanning Probe Lithography; ACS Applied Materials and Interfaces (2017)

[8] S. Zimmermann et al. Silk Fibroin as a Resist for Thermal Scanning Probe Lithography, 43rd MNE Conference, Braga, Portugal, September 18-22, (2017)

BIOGRAPHY

Juergen Brugger is Full Professor at the Ecole Polytechnique Federale de Lausanne (EPFL), Switzerland in Microengineering and Materials Science. Before joining EPFL he was at the MESA Research Institute of Nanotechnology at the University of Twente in the Netherlands, at the IBM Zurich Research Laboratory, and at the Hitachi Central Research Laboratory, in Tokyo, Japan. He received his Master in Physical-Electronics and his PhD degree from Neuchatel University, Switzerland. Research in Juergen Brugger's laboratory focuses on various aspects of MEMS and Nanotechnology. Over the past 18 years the group has made several important contributions to the field, at the fundamental level as well as in technological development, as demonstrated by the start-ups that spun off from the lab. In his research, key competences are in micro/nanofabrication, additive micro-manufacturing, new materials for MEMS for biomedical applications. Over the past 10 years, he published over 200 peer-refereed papers, supervised 20 PhD students. Former students and postdocs have been successful in receiving awards and starting their own scientific careers. Juergen Brugger has been appointed in 2016 Fellow of the IEEE "For contributions to micro and nano manufacturing technology". In 2017 he was awarded an ERC AdvG in the field of advanced micro-manufacturing. In his spare time, he enjoys sailing, wine tasting and pasta cooking, ideally simultaneously.

Plenary Talk 2
Friday, April 12, 2019, 9:25 - 10:00
Thai Chitlada 1, 2/F
Chair: Ting-Hsuan CHEN, City University of Hong Kong

MEMS for Linking AI and the Physical World

Norman Chihnan TIEN

Department of Electrical and Electronic Engineering,

The University of Hong Kong

ABSTRACT

Rapid advances are being made in the fields of computer science and engineering related to artificial intelligence (AI) including topics such as deep learning, data analytics, cloud computing, image processing and block chain. Essentially, our society is entering a dynamic age of digital transformation. The full impact of these technologies will be felt as they interact with our physical world. The tremendous advances in autonomous systems and robotics applications are primarily due to increased “smartness” (intelligence) as exemplified by self-driving vehicles. Deep learning is at its best when there are large or massive amounts of high-quality data. AI systems will be increasingly deployed in dynamic environments where rapid adjustments will be expected. It is clear that the near-term realization of the potential of AI requires continued advances in integrated sensor technologies. There will be new demands and requirements on future sensors, actuators and microsystems. Issues such as scalability, cost, function and performance may need to be addressed from a new perspective. The critical nature of some autonomous systems such as in transportation, calls for attention to the robustness, resiliency, security and “trust” of sensor systems and hardware. Some resulting sensor technologies may need to push their physical limits.

BIOGRAPHY

Professor Norman C. Tien is the Taikoo Professor of Engineering and Chair Professor of Microsystems Technology in the Department of Electrical and Electronic Engineering at the University of Hong Kong where he served as Dean of the Faculty of Engineering from 2012 to 2018. From 2007 to 2011, he was Dean of Engineering at Case Western Reserve University in Cleveland, Ohio. He launched initiatives at these engineering schools to position them to meet the needs of a rapidly changing world. Professor Tien's research interests are in the area of micro and nanotechnology including microelectromechanical systems (MEMS). A pioneer in MEMS for optical applications, his research has also been applied in wireless communications, biomedical systems and environmental monitoring. With over 135 publications in the field, he has graduated 14 Ph.D. students. He has held faculty positions previously at UC Davis, UC Berkeley and Cornell University, and received a distinguished title of Honorary Professor of Tianjin University. He received his Ph.D. from University of California, San Diego, M.S. from University of Illinois, Urbana-Champaign, and B.S. from University of California, Berkeley.

Plenary Talk 3
Saturday, April 13, 2019, 8:50 - 9:25
Thai Chitlada 1, 2/F
Chair: Gwo-Bin Vincent LEE, National Tsing Hua University

Innovation in Sensing Using Mirco- and Nanotechnologies for Biomedical Application

Fumihito ARAI

Department of Micro-Nano Mechanical Science & Engineering,

Nagoya University

ABSTRACT

Sensing is quite important to investigate internal state of the biological objects including human. Mirco- and nanotechnologies play an important role to realize innovation in sensing. For example, force sensing is quite important for biomedical application. In this talk, we introduce several force sensing methods especially applied for biomedical application. We especially focus on how to extend the measurement range of force sensing. We have developed a force sensor using a quartz crystal resonator (QCR) with a wide measurement range of 1.5 × 10e+6 (0.4 mN to 600 N). The proposed sensor allows a higher allowable force with high sensitivity1-3. The force sensor mainly consists of three layers, namely a QCR layer and two holding layers. As opposed to the conventional holding layer composed of silicon1,2, quartz crystal is utilized for the holding layers to improve the temperature characteristic of the force sensor3. There are many new applications of force sensor having such wide dynamic range. For example, it is effective for the measurement of biosignals of human. Monitoring multiple biosignals, such as heart rate, respiration cycle, and weight transitions2, contributes to the health management of individuals. Specifically, it is possible to measure multiple biosignals using load information obtained through contact with the environment, such as a chair and bed, in daily use. A wide-range force sensor is essential since force information contains multiple biosignals with various force ranges. Moreover, there are many new applications of force sensor having wide dynamic range. Some of our current application examples will be introduced, such as detection of a passenger in a car, Bionic Eye surgery Evaluator (Bionic-EyETM), and measurement of the stiffness of biological small objects such as spheroid4, and so on. The other sensing methods, such as in-process monitoring of culture conditions using fluorescent dye, will also be introduced as one of key sensing methods for future tissue engineering.

REFERENCES

1. Y. Murozaki, K. Nogawa, F. Arai, “Miniaturized load sensor using quartz crystal resonator constructed through microfabrication and bonding,” ROBOMECH J. 1, 3, 2014.

2. Y. Murozaki, S. Sakuma, F. Arai, “Detection of Multi-biosignal Using A Quartz Crystal Resonator based Wide Range Load Sensor with Compact Frequency Counter,” In Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems, Korea, pp. 5585–5590, October 2016.

3. Y. Murozaki, S. Sakuma, F. Arai, “Improvement of the Measurement Range and Temperature Characteristics of a Load Sensor Using a Quartz Crystal Resonator with All Crystal Layer

Components," Sensors, 2017, 17(5), 1067(13 pages)

4. S. Sakuma, A. Sato, N. Kojima, F. Tao, F. Arai, "Force Sensor Probe Using Quartz Crystal Resonator with Wide Measurement Range for Mechanical Characterization of HepG2 Spheroid", Sensors and Actuators A, 265, pp. 202-210, 2017

BIOGRAPHY

Fumihito Arai is a Professor of Department of Micro-Nano Mechanical Science & Engineering at Nagoya University, Japan. He also serves as a Deputy Director of Institute of Nano-Life-Systems at Nagoya University. He received Master of Engineering degree from Tokyo Univ. of Science in 1988. He received Dr. of Engineering from Nagoya University in 1993. Since 1994, he was Assistant Professor of Nagoya University. Since 2005, he was Professor of Tohoku University. Since 2010, he has been Professor of Nagoya University. He was the Vice-President for Technical Activities, IEEE Nanotechnology Council (2002, 2003). He was AdCom Member of IEEE Robotics and Automation Society (RAS) (2009-2011, 2012-2014), and he serves as AdCom Member of RAS again since 2019. He was the Vice President for Technical Activities, IEEE RAS (2014-2015, 2016-2017). He was Editor in Chief of Advanced Robotics (2012-2017). His research fields are Micro-nano Robotics and Bio-Robotics. He received 87 awards on his research activities, for example, Early Academic Career Award in Robotics and Automation from IEEE Robotics and Automation Society in 2000, Best Conference Paper Award at ICRA2012. He is the author of 371 journal papers. He is a member of IEEE.

Plenary Talk 4
Saturday, April 13, 2019, 9:25 - 10:00
Thai Chitlada 1, 2/F
Chair: Ting-Hsuan CHEN, City University of Hong Kong

Robotic Intracellular Manipulation and Measurement

Yu SUN

Department of Mechanical and Industrial Engineering,

University of Toronto

ABSTRACT

The ability to directly interrogate intracellular structures inside a single cell for measurement and manipulation is important for understanding subcellular and suborganelle activities, diagnosing diseases, and developing new therapeutic approaches. Compared with measurements of single cells, physical measurement and manipulation of subcellular structures and organelles remain underexplored. This talk will begin with a brief review of the evolution of the robotic cell manipulation field, followed by an introduction of tethered and untethered techniques for physical measurement of intracellular properties and for manipulating structures inside a single cell. I will then discuss sub-micrometer position control and sub-nanonewton force control for realizing 3D magnetic intracellular manipulation and mechanical measurement. Examples of robotic intra-embryonic measurement (inner pressure, trophoblast, and inner cell mass) and intracellular measurement (cell nucleus) for revealing physical changes during embryo development and cancer progression will be given.

BIOGRAPHY

Yu Sun is a Professor in the Department of Mechanical and Industrial Engineering, with joint appointments in the Institute of Biomaterials and Biomedical Engineering and the Department of Electrical and Computer Engineering at the University of Toronto (UofT). He is a Tier I Canada Research Chair, and the founding Director of the UofT Robotics Institute. His Advanced Micro and Nanosystems Laboratory specializes in developing innovative technologies and instruments for manipulating and characterizing cells, molecules, and nanomaterials. He was elected Fellow of ASME (American Society of Mechanical Engineers), IEEE (Institute of Electrical and Electronics Engineers), AAAS (American Association for the Advancement of Science), NAI (US National Academy of Inventors), and CAE (Canadian Academy of Engineering) for his work on micro-nano devices and robotic systems.

Plenary Talk 5
Sunday, April 14, 2019, 8:50 - 9:25
Thai Chitlada 1, 2/F
Chair: Wen Jung LI, City University of Hong Kong

Room Temperature Magnetic Field Sensing Using the Magneto-Electric Effect in Single Phase Hexaferrite Thin

Fabrizio LOMBARDI

Department of Electrical and Computer Engineering,

Northeastern University

ABSTRACT

The development of new magnetic field sensors that are capable of detecting low-frequency small magnetic fields at room temperature has long been an important area of research. The ability to detect small fields with high sensitivity is very critical for a wide range of uses including non-invasive biomedical applications such as magnetocardiography and magnetoencepthalogy. Novel techniques for magnetic field sensing applications based on the magnetoelectric (ME) effect have previously been explored in bulk SrCo2Ti2Fe8O19 materials and single-phase hexaferrite thin films. Since the Magneto-Electric (ME) effect can be used for passive magnetic field sensing at room temperature, it is highly suitable for designing the next generation of magnetic field sensors. Initially, we have observed that in single-phase hexaferrite materials, a thin layer of ME hexaferrite film can be used to convert an input magnetic field into an electric voltage while producing very high ME coupling at room temperature.

Based on these observations, an alternative method for detecting both DC and low frequency AC magnetic fields using hexaferrite thin films will be presented in this talk. The proposed sensors are designed, fabricated and assessed to have a good linear operating range, while consuming only a small amount of power and occupying a relatively small chip area. The design and experimental implementation of bi-directional ME sensors that can determine both magnitude and direction of an incident magnetic field as an alternative to portable magnetic field sensors such as fluxgate magnetometers are also briefly presented. Finally, this presentation will focus on modeling, fabricating, testing and evaluating ME-based sensors in terms of their detection range, noise performance, direction sensing capabilities as well as compatibility with existing CMOS technologies.

BIOGRAPHY

Fabrizio Lombardi graduated in 1977 from the University of Essex (UK) with a B.Sc. (Hons.) in Electronic Engineering. In 1977 he joined the Microwave Research Unit at University College London, where he received the Master in Microwaves and Modern Optics (1978), the Diploma in Microwave Engineering (1978) and the Ph. D. from the University of London (1982). He is currently the holder of the International Test Conference (ITC) Endowed Chair at Northeastern University, Boston. Dr. Lombardi is the Editor-in-Chief of the IEEE Transactions on Nanotechnology and a member of the Executive Boards of the IEEE Nanotechnology Council and the IEEE Computer

Society. He is also the Vice-President for Publications of the IEEE Computer Society and member of the IEEE Publication Services and Products Board (PSPB). In the past Dr. Lombardi has been a two 2-year term Editor-in-Chief (2007-2010), Associate Editor-in-Chief (2000-2006) and Associate Editor (1996-2. 000) of the IEEE Transactions on Computers, the inaugural two-term Editor-in-Chief of the IEEE Transactions on Emerging Topics in Computing (2013-2017) as well as member of Editorial Boards of ACM/IEEE periodicals. Dr. Lombardi is a Fellow of the IEEE for ”contributions to testing and fault tolerance of digital systems”. He was the recipient of the 2011 Meritorious Service Award and elevated to Golden Core membership in the same year by the IEEE Computer Society; he is the Chair of the 2016 and 2017 IEEE CS Fellow Evaluation Committee. He has been awarded by the IEEE Nanotechnology Council the 2019 Distinguished Service Award. He has received many professional awards: the Visiting Fellowship at the British Columbia Advanced System Institute, University of Victoria, Canada (1988), twice the Texas Experimental Engineering Station Research Fellowship (1991-1992, 1997-1998) the Halliburton Professorship (1995), the Outstanding Engineering Research Award at Northeastern University (2004) and an International Research Award from the Ministry of Science and Education of Japan (1993-1999). Dr. Lombardi was the recipient of the 1985/86 Research Initiation Award from the IEEE/Engineering Foundation and a Silver Quill Award from Motorola-Austin (1996). Together with his students, his manuscripts have been selected for the best paper awards at technical events/meeting such as IEEE DFT and IEEE/ACM Nanoarch. His research interests are emerging technologies (mostly nanoscale circuits and magnetic sensor/memory devices), innovative computational paradigms and self-assembly.

Plenary Talk 6
Sunday, April 14, 2019, 9:25 - 10:00
Thai Chitlada 1, 2/F
Chair: Jin-Woo KIM, University of Arkansas

PERFECT Filter: Precise, Efficient, Rapid, Flexible, Easy-operated, Controllable, Thin filter

Wei WANG

Institute of Microelectronics,

Peking University

ABSTRACT

A precise, efficient, rapid, flexible, easy-operated, controllable, thin filter, shorted as PERFECT filter, was developed based on the Parylene microelectromechanical system (MEMS) technique. Large (>20 mm×20 mm) filtration membranes containing a 2.5-dimensional (2.5D) micropore array with an ultra-high porosity (up to 91.37% with designed pore diameter/space of 100 μm/4 μm) were prepared by a Parylene molding process. The notation 2.5D indicates that the large area and the relatively small thickness (approximately 10μm) of the fabricated membranes represent 2D properties, while the large thickness-to-width ratio (10 μm/<4 μm) of the spaces between the adjacent pores corresponds to a local 3D feature. The large area and high porosity of the micropore array achieved filtration with high throughputs up to 180 mL/min for PBS solution and 17 mL/min for whole blood simply driven by gravity. Meanwhile, the high mechanical strength, benefiting from the 2.5D structure of the micropore array, ensured a negligible pore size variation during the high-throughput filtration, thereby enabling high size resolution separation, which was proven by single-layer and multi-layer filtrations for particle separation. Furthermore, as preliminary demonstrations, this 2.5-dimensional Parylene C micropore array was implemented as an efficient filter for rare cancer cell separation from a large volume, approximately 10 cells in 10 mL PBS and undiluted urine, with high recovery rates of 87±13% and 56±13%, respectively. Tumor cells from bronchoalveolar lavage fluid, sputum, pleural fluid, etc were also tested and indicated that the present PERFECT filter holds promising future in clinical diagnosis.

BIOGRAPHY

Prof. Wei Wang is the Director of MEM center in Peking University, also vice director of Institute Microelectronics, Peking University and the National Key Laboratory of Science and Technology on Micro/ Nano Fabrication. He received his B.S. in Thermal engineering from University of Shanghai for Science and Technology (USST, 1999) and the Ph.D. in Thermal Engineering from Tsing University (2005). He was a Visiting Professor in UC Davis (with Prof. Tingrui Pan) from 2007-2008 and Caltech (with Prof. YC Tai) from 2014-2015. His research focus is in the area of Parylene MEMS, clinical micro/nanosystem, and thermal management of 3D microsystem. He has published over 100 peer-reviewed articles, over 50 presentations with over 15 invited presentations, and 15 patents pending or granted. He has served/ is serving on organizing committees for several international conferences, including IEEE MEMS'2015 and '2016, Transducers'2019 etc.

Plenary Talk 7
Sunday, April 14, 2019, 16:30 - 17:15
Thai Chitlada 1, 2/F
Chair: Yufeng JIN, Peking University

Triboelectric Nanogenerator for Self-powered Systems

Zhong Lin WANG

School of Materials Science and Engineering,

Georgia Institute of Technology

ABSTRACT

Self-powered system is a system that can sustainably operate without an external power supply for sensing, detection, data processing and data transmission. Nanogenerators (NG) were first developed for self-powered systems based on piezoelectric effect and triboelectrification effect for converting tiny mechanical energy into electricity, which have applications in internet of things, environmental/infrastructural monitoring, medical science, environmental science and security. Here, we first present the fundamental theory of the NGs starting from the Maxwell equations. In the Maxwell's displacement current proposed in 1861, the term $\mathcal{E}\frac{\partial \boldsymbol{E}}{\partial t}$ gives the birth of electromagnetic wave, which is the foundation of wireless communication, radar and later the information technology. Our study indicates that, owing to the presence of surface polarization charges present on the surfaces of the dielectric media in NG, an additional term $\frac{\partial P_s}{\partial t}$ should be added in the Maxwell's displacement current, which is the output electric current of the NG. Therefore, our NGs are the applications of Maxwell's displacement current in energy and sensors. NGs have three major application fields: micro/nano-power source, self-powered sensors and blue energy. We will present the applications of the NGs for harvesting all kind mechanical energy that is available but wasted in our daily life, such as human motion, walking, vibration, mechanical triggering, rotating tire, wind, flowing water and more. Then, we will illustrate the networks based on triboelectric NGs for harvesting ocean water wave energy, for exploring its possibility as a sustainable large-scale power supply. Lastly, we will show that NGs as self-powered sensors for actively detecting the static and dynamic processes arising from mechanical agitation using the voltage and current output signals.

REFERENCES

1. Z.L. Wang, *Materials Today,* 20 (2017) 74-82.

2. "Nanogenerators for Self-Powered Devices and Systems", by Z.L. Wang, published by Georgia Institute of Technology (first book for free online down load).

3. Z.L. Wang, L. Lin, J. Chen. S.M. Niu, Y.L. Zi "Triboelectric Nanogenerators", Springer, 2016.

4. Z.L. Wang "Triboelectric Nanogenerators as New Energy Technology for Self-Powered Systems and as Active Mechanical and Chemical Sensors", ACS Nano 7 (2013) 9533-9557.

5. Z.L. Wang, J. Chen, L. Lin "Progress in triboelectric nanogenertors as new energy technology and self-powered sensors", Energy & Environmental Sci, 8 (2015) 2250-2282.

BIOGRAPHY

Dr. Zhong Lin (ZL) Wang is the Hightower Chair in Materials Science and Engineering and Regents' Professor at Georgia Tech · and Founding Director and Chief Scientist at Beijing Institute of Nanoenergy and Nanosystems. Dr. Wang pioneered the nanogenerators from fundamental principle to technological applications. His research on self-powered nanosystems has inspired the worldwide effort in academia and industry for studying energy for micro-nano-systems. He coined and pioneered the fields of piezotronics and piezo-phototronics for the third generation semiconductors. Wang is ranked No. 1 in Google Scholar public profiles in Nanotechnology & Nanoscience both in total citations and h-index impacts: http://www.webometrics.info/en/node/198.

Dr. Wang has received 2018 ENI award in Energy Frontiers; Global Nanoenergy Prize, The NANOSMAT Society, UK (2017); Distinguished Research Award, Pan Wen Yuan foundation (2017); Distinguished Scientist Award from (US) Southeastern Universities Research Association (2016); Thomas Router Citation Laureate in Physics (2015); World Technology Award (Materials) (2014); Distinguished Professor Award (Highest faculty honor at Georgia Tech) (2014); NANOSMAT prize (United Kingdom) (2014); The James C. McGroddy Prize in New Materials from American Physical Society (2014); MRS Medal from Materials Research Soci. (2011).

Dr. Wang was elected as a foreign member of the Chinese Academy of Sciences in 2009, member of European Academy of Sciences in 2002, academician of Academia of Sinica (Taiwan) 2018; fellow of American Physical Society in 2005, fellow of AAAS in 2006, fellow of Materials Research Society in 2008, fellow of Microscopy Society of America in 2010, fellow of the World Innovation Foundation in 2002, fellow of Royal Society of Chemistry, and fellow of World Technology Network 2014. Dr. Wang is the founding editor and chief editor of an international journal Nano Energy, which now has an impact factor of 15. Details can be found at: http://www.nanoscience.gatech.edu

Keynote Talk 1
Saturday, April 13, 2019, 10:20 - 10:45
Thai Chakkraphat 1, 2/F
Chair: Aaron Ohta, University of Hawaii

Soft Electronics for Noninvasive Healthcare: From the Skin to Below the Skin

Sheng XU

Department of NanoEngineering,

University of California San Diego

ABSTRACT

Soft electronic devices that can acquire vital signs from the human body represent an important trend for healthcare. Combined strategies of materials design and advanced microfabrication allow the integration of a variety of components and devices on a stretchable platform, resulting in functional systems with minimal constraints on the human body. In this presentation, I will demonstrate a wearable multichannel patch that can sense a collection of signals from the human skin in a wireless mode. Additionally, integrating high-performance ultrasonic transducers on the stretchable platform adds a new third dimension to the detection range of conventional soft electronics. Ultrasound waves can penetrate the skin and noninvasively capture dynamic events in deep tissues, such as blood pressure and blood flow waveforms in central arteries and veins. This stretchable platform holds profound implications for a wide range of applications in consumer electronics, sports medicine, defense, and clinical practices.

BIOGRAPHY

Sheng Xu is currently an assistant professor in the Department of Nanoengineering at UC San Diego. He received his B.S. in Chemistry and Molecular Engineering from Peking University in Beijing, China, and Ph.D. in Materials Science and Engineering from Georgia Institute of Technology. He worked as a postdoctoral research associate in the Department of Materials Science and Engineering at the University of Illinois at Urbana-Champaign. His research group currently focuses on biointegrated electronics for health monitoring and human-machine interfaces. His research has been highlighted as “Groundbreaking Research in 2018” by Forbes, “12 innovations that will revolutionize the future of medicine” by National Geographic, and 2018 National Institute of Health (NIH)-wide end-of-year review. He has been recognized by a series of awards, including the MIT Technology Review 35 Innovators Under 35, NHLBI Technology Development Award, 3M Non-Tenured Faculty Award, Samsung Global Research Outreach Award, International Union of Pure and Applied Chemistry Prize for Young Chemists, and the most recent Materials Research Society Outstanding Young Investigator Award (the only recipient this year from nominees worldwide).

Keynote Talk 2
Friday, April 12, 2019, 10:20 - 10:45
Thai Chakkraphat 2, 2/F
Chair: Haixia ZHANG, Peking University

Camouflaged Nanoparticles-Mediated Theranostic Drug Delivery to Tumor

Shang-Hsiu HU

Department of Biomedical Engineering and Environmental Sciences,

National Tsing Hua University

ABSTRACT

Delivery of drug and energy within responsive carriers that effectively target and accumulate in cancer cells promise to mitigate side effects and to enhance the uniquely therapeutic efficacy demanded for personalized medicine. To achieve this goal, however, these carriers which are usually piled up at the tumors periphery near the blood vessels must simultaneously overcome the challenges in low tumor penetration and transport sufficient cargos to the deep tumor to eradicate whole cancer cells. Here, we report a sponge-like carbon material on graphene nanosheet (graphene nanosponge)-supported lipid bilayers (lipo-GNS) that doubles as a photothermal agent and high cargo payload platform, which releases a burst of drug/energy (docetaxel (DTX) and gasified perfluorohexane (PFH)) and intense heat upon near-infrared irradiation. Ultrasmall lipo-GNS (40 nm) modified with a tumor targeting protein that penetrates the tumor spheroids through transcytosis exhibited a 200-fold increase in accumulation than a 270 nm variant of the lipo-GNS. Furthermore, a combination of therapeutic agents (DTX and PFH) delivered by lipo-GNS deep into tumors was gasified and released into the tumor spheroids, and successfully ruptured and suppressed xenograft tumors in 16 days without distal harm when subjected to a single 10 min near infrared (NIR) laser treatment.

BIOGRAPHY

Dr. Shang-Hsiu Hu (BS - Chemical Engineering - 2004, NCHU; MS - Materials - 2006, NCTU; PhD - Materials - 2010, NCTU) has been an associate professor at National Tsing Hua University since 2017 (Department of Biomedical and Environmental Sciences). His research explores novel nanomaterials and nanotechnologies in order to develop advanced drug and gene delivery systems with the promise to improve health care. Highly integrating interdisciplinary knowledge and technology, he seeks to improve nanoparticle synthesis and formulation and its therapeutic efficacy. He received NTHU young faculty research award (2015) and Prof. Chao-Ren Lee-young scholar award (2015), Taiwan MOST Ta-You Wu Memorial Award (2017), MOST Young Scholar Fellowship (2018).

Keynote Talk 3
Friday, April 12, 2019, 10:45 - 11:10
Thai Chakkraphat 1, 2/F
Chair: Aaron Ohta, University of Hawaii

Micro/Nano-engineered sensors for environmental and healthcare monitoring applications in IoT Era

Inkyu PARK

Department of Mechanical Engineering,

Korea Advanced Institute of Science and Technology (KAIST)

ABSTRACT

The importance of smart sensors towards convenient and safe life is rapidly increasing in the era of internet of things (IoT) and industry 4.0. Especially, micro and nanotechnologies are enabling new functionalities of ultracompact and low-power sensors that are essential for the IoT era. In this talk, I will present micro/nano-enabled sensors for high performance environmental and healthcare monitoring applications. In specific, the following topics will be discussed:

1) Nanostructured metal oxide materials on MEMS platform for low-power and high-performance gas sensors
2) Silicon nanostructure array sensor for low-power flammable gas detection
3) Conductive nanomaterial – elastomer composite for highly stretchable strain sensors towards human motion and posture detection
4) Micro/nano-structured soft materials for highly sensitive pressure detection with large dynamic range
5) Self-powered sensors for environmental and healthcare monitoring applications
6) Multiplexed sensor integrated needle for clinical applications such as biopsy and RF ablation procedures

BIOGRAPHY

Prof. Inkyu Park received his B.S., M.S., and Ph.D. from KAIST (1998), UIUC (2003) and UC Berkeley (2007), respectively, all in mechanical engineering. He has been with the department of mechanical engineering at KAIST since 2009 as a faculty and is currently a KAIST Chair Professor. His research interests are nanofabrication, smart sensors, nanomaterial-based sensors and flexible & wearable electronics. He has published more than 80 international journal articles (SCI indexed) and 130 international conference proceeding papers in the area of MEMS/NANO engineering. He is a recipient of IEEE NANO Best Paper Award (2010) and HP Open Innovation Research Award (2009-2012).

Keynote Talk 4
Friday, April 12, 2019, 10:45 - 11:10
Thai Chakkraphat 2, 2/F
Chair: Haixia ZHANG, Peking University

Cell-Sized Molecular Robot and Beyond

Shinichiro NOMURA

Department of Robotics,

Division of Mechanical Engineering,

Tohoku University

ABSTRACT

Synthesizing live cell from scratch is one of the ultimate dreams of engineers. Before facing that stage, there is a practical theme of building an organization consisting of functional molecular devices. We would like to call such an integrated system as molecular robots [1]. In general, "robot" is a term for a mechanism in which devices such as sensors, actuators, logic circuits, and bodies are integrated. Making it possible to design all these elements by molecules and to perform the desired operation is fundamental research not only in the chemical field but also in mechanical engineering. It is expected to acquire new design principles of artifacts, in a small, moist and random world. Through by creating molecular robots, it will give us the opportunity to understand how to connect the hierarchy between living organisms and designed molecules. We have constructed an artificial structure using lipid membrane vesicle as a cell-model structure. A model that introduces a protein synthesis system based on gene expression [2], a model that expresses a membrane protein to function the membrane [3], and performs a substance exchange with a living cell (FIG. A) [4], amoeba type molecular robot (Fig. B) capable of expressing continuous shape change in response to signal molecules has been constructed [5]. The latest one, ameba robot consists of a body (cell-sized vesicle), an actuator (kinesin/microtubule), and designed control device (molecular clutch: made of artificial DNA). The molecular clutch couples the motors with the body by the single-stranded DNA having a specific sequence, and this "robot" started a continuous shape change from a stationary state. Also, when the clutch is disconnected by another DNA signal, the shape change behavior stopped. These results show that the constituent elements of various molecules are integrated as a system and show the possibility of control the behavior by DNA computer. This prototype is designed to be able to install and evaluate unique molecular devices designed by researchers, and we are convinced that it will provide a useful platform for artificial-cell /molecular robot engineering. In addition, I will introduce recent research results aiming at implementing a more powerful and programmable system

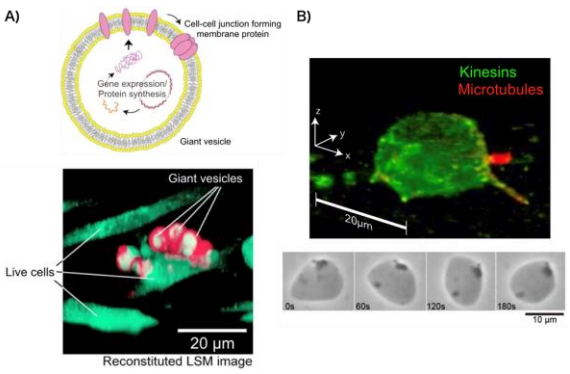


Figure: Example of artificial-cellular/molecular robots. A) membrane protein synthesizing vesicles have an ability to dock with live cells for exchanging their contents. B) Amoeba-type vesicles start their continuous shape shift by DNA signal input with molecular motors.

to the molecular robot.

REFERENCES

[1] S. Murata, M. Hagiya *et al.*, *New Generation Computing* **31**, 27–45 (2013).

[2] S.-i. M. Nomura, K. Akiyoshi *et al.*, *J. Biotechnology* **133**, 190-195 (2008).

[3] M. Kaneda, S.-i. M. Nomura *et al.*, *Biomaterials* **30**, 3971-3977 (2009).

[4] Y. Sato, S.-i. M. Nomura *et al.*, *Science Robotics* **2(4)**, aal3735 (2017).

BIOGRAPHY

Shin-ichiro M. NOMURA is an associate professor of molecular robotics, Department of Robotics, Graduate school of Engineering at TOHOKU University, Japan. He received his bachelor's degree from the Shizuoka University (1997), a master's degree from the Nagoya University (1999), and Ph.D in Science from the Kyoto University (2002). He joined Tokyo Medical & Dental University as post-doc and Research Associate Professor (junior), then moved WPI-iCeMS, Kyoto University. (2008-2011). Since 2011, he has become the associate professor at Department of robotics, Tohoku University. His research interests are artificial-cell engineering, applied biophysics, and molecular robotics.

Keynote Talk 5
Saturday, April 13, 2019, 10:20 - 10:45
Thai Chakkraphat 1, 2/F
Chair: Che-Hsin LIN, National Sun Yat-sen University

Nature-inspired topological surfaces for water and energy nexus: From liquid diode to pancake bouncing

Zuankai WANG

Department of Mechanical Engineering

City University of Hong Kong

ABSTRACT

The progress of humankind has been marked by five main waves of innovation. Each wave has transformed our industries and societies, yet is also coupled with the consumption of resources, pollution, and energy/water shortage. In contrast, honed by billion years' evolution, nature has developed extraordinary principles which are characterized with green energy and resilience. This talk focuses on how the design of nature-inspired materials will address the grand challenges facing us such as water and energy.

In particular, I will discuss our recent progress in the exploration of various nature-inspired topological structures for various engineering implementations. I will show that the rational design and control of topological effect, which is generally overlooked in the conventional design, will be able to fundamentally change the solid/liquid interfaces, extend the boundaries of conventional engineering, and spur innovations for various implementations such as thermal management, reversible adhesion, electricity generation, liquid diode-like transport and soft robot (1-7).

REFERENCES

[1] Xu, W.; Zhou, X.; Hao, C.; Zheng, H.; Yan, X.; Liu, Y.; Yang, Z.; Leung, M.; Zeng, X.; Xu, R.; Wang, Z. SLIPS-TENG: Robust triboelectric nanogenerator with optical and charge transparency using slippery interface. National Science Review, 2019

[2]Li, J.; Li, J.; Sun, J.; Feng, S.; Wang, Z. Biological and engineered topological droplet rectifiers. Advanced Materials, 2019, doi:10.1002/adma.201806501

[3] Lu, H.; Zhang, M.; Yang,Y.; Huang, Q.; Fukuda, T.;Wang, Z.; Shen, Y. A bio-inspired multi-legged millirobot that functions in both dry and wet conditions. Nature Communications, 2018, 9, 3944.

[4]Li, J.;Zhou, X.; Li, J.; Che, L.; Yao, J.; McHale, G.; Chaudhury, M.; Wang, Z. Topological liquid diode, Science Advances, 2017, 3, eaao3530.

[5] Zhao, Y.; Wu, Y.; Wang, L.; Zhang, N.; Chen, X.; Liu, M.; Fan, J.; Liu, J.; Zhou, F.;Wang, Z. Bio-inspired reversible underwater adhesive. Nature Communications, 2017, 8, 2218.

[6]Li, J.; Hou, Y.; Liu, Y.; Hao, C.; Li, M., Chaudhury, M.; Yao, S.; Wang, Z. Directional transport of high temperature Janus droplet mediated by structural topography. Nature Physics, 2016, 12, 606-

612.

[7] Liu, Y.; Moevius, M.; Xu, X.; Qian, T.; Yeomans, J.; Wang, Z. Pancake bouncing on superhydrophobic surfaces. Nature Physics, 2014, 10, 515-519.

BIOGRAPHY

Dr. Zuankai Wang is currently a professor in the Department of Mechanical Engineering at the City University of Hong Kong, and one of the founding members of Young Academy of Science of Hong Kong. He earned his B.S. degree in Mechanical Engineering from Jilin University in 2000 and Master degree in Microelectronics from Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences, in 2003, and Ph. D. degree in Mechanical Engineering at Rensselaer Polytechnic Institute in 2008. After one year postdoc training in Biomedical Engineering at Columbia University, he joined in the City University of Hong Kong in September 2009 as an assistant professor. Over the past four years, his research group has published 9 papers in Nature/Science Series Journals. His work has been included in the Guinness Book of World Records, and highlighted in Nature, Nature Physics and many other media coverages. Prof. Wang has received many awards including the 35th World Cultural Council Special Recognition Award (2018), President's Lectureship at City University of Hong Kong (2018, the first Professor to deliver this lecture), Outstanding Research Award (Senior, 2017) and President's Award at the City University of Hong Kong (2017, 2016), Changjiang Chair Professor by Ministry of Education of China (2016). Outstanding Youth Award conferred by the International Society of Bionic Engineering (2016), OSA Young Scientist Award (2016). The Ph.D. students he supervised have won a number of prestigious awards including Young 1000 Talent Plan (2017, two PHD graduates), MRS Graduate Student Gold Award (2016 Fall Meeting), Hiwin Doctoral Dissertation Award (2016), Hong Kong Young Scientist Award (2015), and MRS Graduate Student Silver Award (2015 Spring Meeting).

Keynote Talk 6
Saturday, April 13, 2019, 10:20 - 10:45
Thai Chakkraphat 2, 2/F
Chair: Megan Yi-Ping HO, The Chinese University of Hong Kong

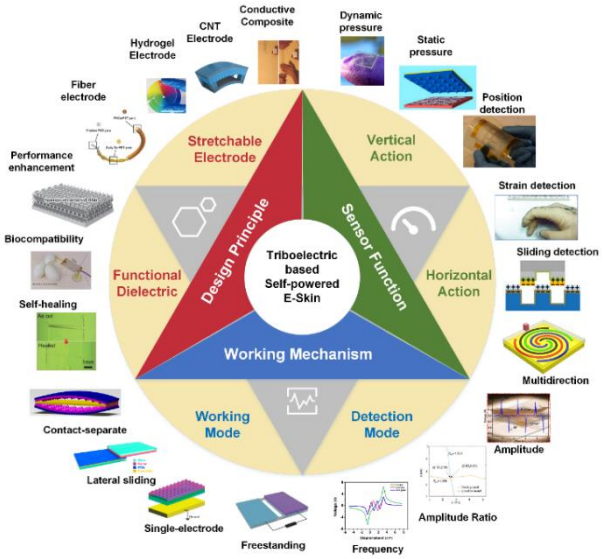
Triboelectric-based Self-Powered Smart Skin

Haixia (Alice) ZHANG

Institute of Microelectronics,

Peking University

ABSTRACT



In the past decades, the development of new material and fabrication process make the electronics engineering bloom again from the traditional silicon-based electronics to the polymer based stretchable electronics. This talk will focus on the TENG based self-powered smart skin devices, which is beneficial for solving the energy supply problem of sensor networks in the stretchable electronic system. We firstly summarize the choice of the working mode and the detection mode, which is the fundamental point for designing a proper e-skin with the expected function. Furthermore, the method to mimic the properties of human skin, which must meets the demands of mechanical stretchability and electrical conductance at the same time, is reviewed from the electrode aspect and dielectric aspect, respectively. The material development and structure construction are two main approaches for making the conductor into stretchability. For the dielectric, the methods to improve the performance and endow more human skin functions like biocompatibility, self-healing and humidity-resistance are also stated. Furthermore, the state-of-the-art functional self-powered e-skins such as pressure sensor, position sensor, strain sensor and sliding sensor, are demonstrated to discuss their great potential in different application fields.

BIOGRAPHY

Dr. Zhang is a pioneer and world leader for her outstanding research achievements and creativity in micro/nanotechnology, especially in high efficiency energy harvesting and self-powering devices & systems. Her research has impacted the field of MEMS field in a number of aspects, such as developing mass production technology of micro-nano structures with high surface charging density based on MEMS fabrication to enhance the performance of triboelectric nanogenerator, applying piezoelectric, magnetic and triboelectric principles for hybrid nanogenerator, and high efficiency energy management circuit to achieve long-term power supply for microsystems, her contributions of active sensing and smart skin also inspect the academic field worldwide.

Dr. Zhang has productive scientific output and won numbers of Awards/Honors. She authored and co-authored 250+ peer reviewed scientific articles on the prestigious journals such as, Energy & Environmental Science, Nano Energy, Nano Letters, ACS Nano, Advanced Materials, Advanced Functional Materials, et al. She edited and co-edited 8 books and book chapters, and held 42 patents including 3 US patents. She has delivered 100+ plenaries, keynotes, invited and seminar talks at international and national academic conferences as well as universities and research institutions. She is very active in academic service, was the founder and general Chair of IEEE NEMS conference, NTC Beijing Chapter Chair. She serves on editorial board of IEEE Tnano, JMEMS, Microsystem and Nanoengineering, et al.

Keynote Talk 7
Saturday, April 13, 2019, 10:45 - 11:10
Thai Chakkraphat 1, 2/F
Chair: Che-Hsin LIN, National Sun Yat-sen University

Toward Highly Efficient Solar Water Splitting: A Concurrent Electrical, Optical, and Catalytic Design

Jr-Hau HE

Computer, Electrical and Mathematical Sciences and Engineering (CEMSE) Division,

King Abdullah University of Science & Technology (KAUST)

ABSTRACT

Energy crisis is a broad and complex global topic. Natural resources such as gas and oil are in limited in supply. Development towards renewable resources is one of the most important technologies in the world. Currently, photocatalytic and photoelectrochemical (PEC) water splitting devices under the irradiation of sunlight have received much attention for the production of renewable hydrogen from water. Solar energy conversion and storage through photoelectrolysis of water using semiconductors as both light absorber and energy converter to store solar energy in simple chemical bond, H2, become highly desirable approaches to solving the energy shortage challenge.

We focus on the effort to develop an efficient Si-based PEC water splitting device. We introduce the surface textured Si heterojunction PEC cell consisting of ultrathin amorphous Si/crystalline Si as efficient and robust photoelectrodes. The solar to hydrogen conversion efficiency has been improved to 13.26%, which is the highest ever reported for Si-based photocathodes. Later on, we design the cascading energy band structure in Si via doping for facilitating carrier separation and novel electrode structures for 360° light harvesting for hydrogen generation with ultrahigh current densities of 61.2 mAcm-2. The cells have been further demonstrated with excellent hydrogen production rate. In addition, our method can significantly improve the stability of Si-based solar cells in water to sustain up to 300 hr. These multifunctional designs provide the potential for the future development in the renewable energy market.

BIOGRAPHY

Dr. Jr-Hau He is an Associate Professor of Electrical Engineering at King Abdullah University of Science & Technology (KAUST). He got BS and PhD degrees at National Tsing Hua University in 1999 and 2005, respectively. He was a Visiting Scholar at Georgia Tech (2005), a Postdoc Fellow at National Tsing Hua University (2006) and Georgia Tech (2007), a Visiting Scholar/Professor at Georgia Tech (2008), UC Berkeley (2010 and 2014), and UC San Diego (2012-2013), HKPolyU (Dec. of 2014), and University Lille 1 (May of 2016) and Asistant/tenured Associate Professor at National Taiwan University (2007-2014).

He has been a pioneer in optoelectronics, which reflects on his achievement of photon management on the light harvesting devices. He has conducted highly interdisciplinary researches to bridge those gaps between various research fields and between academia and industry. He has

grants received: > US$ 10M since joining KAUST in July 2014 and garnered >10000 citations for a body of work consisted of >215 peer reviewed journal articles with 55 of H factor over his career and over 215 presentations in international conferences. His researches focus on 2D materials/electronics and photoelectrochemical water splitting and CO2 reduction.

He participates actively in activities and services in scientific professional societies. He is a Fellow of OSA, RSC and SPIE, and a senior member of IEEE. 38 postgraduate students (12 Ph.D. and 27 M.S. students) under his supervision completed their degree studies. Visit his web for more information (nanoenergy.kaust.edu.sa).

Keynote Talk 8
Saturday, April 13, 2019, 10:45 - 11:10
Thai Chakkraphat 2, 2/F
Chair: Megan Yi-Ping HO, The Chinese University of Hong Kong

Nano-acoustics: Materials, Devices and Applications

Xiaoning JIANG

Micro/Nano-Engineering Laboratory,

Department of Mechanical and Aerospace Engineering,

North Carolina State University

ABSTRACT

Research involving acoustics-associated nanomaterials, nanostructures, nanofabrication and devices for a broad range of applications has been actively pursued over the past decade or so. In this talk, reviews are firstly given to the nanoacoustics topics including: interactions of acoustic waves with nano materials including nanoparticles, nano-bubbles, gas vesicles, nanodroplets; nano-materials and nanostructures for photoacoustics and laser ultrasound; acoustic sensors, actuators and transducers involving nanomaterials, and the associated applications in drug delivery, therapy, imaging, material and structural characterization, and micro/nanofabrication. Laser ultrasound transducers consisting of a layer of carbon nanomaterials and a layer of thermal elastic material are next reported as an example of nano-acoustic devices. Design, fabrication and characterization of laser ultrasound transducers are presented, followed by the demonstration of drug delivery and industrial non-destructive testing using these laser ultrasound transducers. Cellular drug delivery with quantum nanodots using a 0.025 mm x 0.025 mm micro-transducer is next presented as an example of nanoacoustics in drug delivery. Nanodroplets mediated sonothrombolysis is also presented with in-vitro tests for its potential in nanoacoustic therapy. Future trend of nano-acoustics research and nano-acoustics applications will be discussed at the end of this talk.

BIOGRAPHY

Dr. Xiaoning Jiang is a University Faculty Scholar and a Distinguished Professor of Mechanical and Aerospace Engineering at North Carolina State University. He is also an Adjunct Professor of Biomedical Engineering at North Carolina State University and University of North Carolina, Chapel Hill. Dr. Jiang received his BS, MS and Ph.D. degrees from Shanghai Jiaotong University (1990), Tianjin University (1992) and Tsinghua University (1997), respectively. He received his Postdoctoral training from the Pennsylvania State University (1997-2001). He was the Chief Scientist and Vice President at TRS Technologies, Inc. prior to joining NC State in 2009. Dr. Jiang is the author and co-author of two books, 5 book chapters, 9 issued US Patents, 101 peer reviewed journal papers and over 105 conference papers on piezoelectric ultrasound transducers, ultrasound for medical imaging and therapy, drug delivery, ultrasound NDT/NDE, smart materials and structures and M/NEMS. Dr. Jiang is a member of the technical program committee for a few international conferences including IEEE Ultrasonics Symposium (TPC-5), SPIE Smart Structures and NDE,

ASME IMECE, IEEE NANO and IEEE NMDC. He also serves as the UFFC representative to IEEE Nanotechnology Council (NTC), NanoAcoustics Technical Committee Chair for IEEE NTC, IEEE NTC Distinguished Lecturer (2018-), an editorial board member for the journal Sensors and a senior associate editor for the ASME Journal of Engineering and Science in Medical Diagnostics and Therapy. Dr. Jiang is an ASME Fellow.

Keynote Talk 9
Sunday, April 14, 2019, 10:20 - 10:45
Thai Chakkraphat 1, 2/F
Chair: Yunlong ZI, The Chinese University of Hong Kong

Microfluidic Techniques for Isolation and Analysis of Floating Cells

Raymond H. L. LAM

Department of Biomedical Engineering

City University of Hong Kong

ABSTRACT

Isolation and analysis of floating cells has been technically challenging, including the cell positioning and characterization of the cells in the floating state. For example, isolation of floating rare cells, such as circulating tumor cells, has low abundance and limited time-frames of expressions of relevant cell characteristics. Deep phenotyping of single cancer cells for both the mechanical and biochemical properties is of critical importance in the era of precision medicine to advance understanding of relationships between gene mutation and cell phenotype and to elucidate the biological nature of tumor heterogeneity. On the other hand, quantitative and dynamic analyses of immune cell secretory cytokines are essential for precise determination and characterization of the "immune phenotype" of patients for clinical diagnosis and treatment of immune-related diseases.

In this presentation, the speaker will present a couple microfluidic techniques for the floating cell analysis: 1) a hydrodynamic mechanism to sequentially trap and isolate floating cancer cells in biosamples through a series of microsieves to obtain up to 100% trapping yield and >95% sequential isolation efficiency, 2) a microfluidic elasticity microcytometer for multiparametric biomechanical and biochemical phenotypic profiling of free-floating, live single cancer cells for quantitative, simultaneous characterizations of cell size, cell deformability/stiffness, and surface receptors, and 3) a microfluidic sensing chip integrated with cytometric fluorescent microbeads for real-time and multiplexed monitoring of immune cell cytokine secretion dynamics, consuming only a negligible sample volume without interrupting the immune cell culture.

BIOGRAPHY

Raymond H. W. Lam is currently working as an Associate Professor in the Department of Biomedical Engineering at City University of Hong Kong. He has obtained a first honor B.Eng. degree and an M.Phil. degree in Automation and Computer-Aided Engineering from Chinese University of Hong Kong, and a Ph.D. degree in Mechanical Engineering from Massachusetts Institute of Technology. Before joining CityU, he was a postdoctoral fellow in the Department of Mechanical Engineering at University of Michigan. He has interdisciplinary research experience in cell mechanobiology, bacteriology, microfluidics, microfabrication, computational methods, software development and circuit/device design. His overall research objective is to bridge science and engineering knowledge and currently he aims at developing/applying microengineering techniques to advance the cell biology research.

Keynote Talk 10
Sunday, April 14, 2019, 10:20 - 10:45
Thai Chakkraphat 2, 2/F
Chair: King Wai Chiu LAI, City University of Hong Kong

Living Cell based Micro Bio-Syncretic Robots: Modeling Manufacturing, and Control

Lianqing LIU

State Key Laboratory of Robotics,

Shenyang Institute of Automation,

Chinese Academy of Sciences

ABSTRACT

Bio-syncretic robots, which are composed of living biological systems and artificial electromechanical systems, have attracted considerable attention for their potential performance. This kinds of robots may offer both the advantages of living organisms, such as high energy conversion efficiency, high energy density, biocompatibility and potential self-repair, and qualities of electromechanical devices, including high accuracy, high strength, and favorable repeatability. Although many current works about bio-syncretic robots have demonstrated the feasibility of the combination of bioactuators with soft materials, most of them only focus on the realization of the bioactuated devices, and lack of quantitative study of the bio-syncretic robots. For example, for living cells based actuation, there are few of theoretical model to describe the actuation mechanism of the beating cells constituting the bio-syncretic robots at microscale. And few of them has implemented the detailed study on the stimulus-response of living cells related to the control of bio-syncretic robots. In this topic, a theoretical model of a single muscle cell at the sub-cellular scale for the actuation and control of bio-syncretic robots will be introduced. And the fabrication, measurement and control methods of micro bio-syncretic robots will be discussed. Finally, a controllable biomimetic micro bio-syncretic crawler based on living beating cells will be demonstrated.

BIOGRAPHY

Lianqing Liu is vice Director of State Key Laboratory of Robotics, and the head of Micro/Nano Robotics and Biosyncretic System Lab, Shenyang Institute of Automation. He received his Ph.D. degree in Pattern Recognition and Intelligent System from university of Chinese Academy of Sciences, China in 2008, and B.S. degree in Industry Automation from Zhengzhou University, China in 2002. He started his career in 2006 at Shenyang Institute of Automation, Chinese Academy of Sciences, and holds the position of Assistant Professor (2006-2008), Associate Professor (2009-2010) and Professor (2011 to now) respectively.

Currently his research interests include Nanorobotics, Intelligent control, and Biosensors. He has published over 100 peer reviewed international journal papers and led more than 20 funded research projects as Principal Investigator. He received the Best Student paper Award in 2015 International Conference on Manipulation, Manufacture and Measurement on the Nanoscale, Best Conference Paper in 2016 IEEE International Conference on Nano/Molecular Medicine and Engineering, and T. J. Tarn Best Paper in Robotics in 2017 IEEE international Conference on

Robotics and Biomimetics.

He was awarded the Early Government/Industrial Career Award by the IEEE Robotics and Automation Society in 2011, Outstanding Young Scientist of Chinese Academy of Sciences in 2014, Rising Star Award of 3M-Nano Society in 2015, Talent Young Scholar Funds of NSFC in 2015, National Program for support of Top-Notch Young Professionals. Lu Jiaxi Young Scientist Award of the Chinese Academy of Sciences in 2011, and president Award of the Chinese Academy of Sciences in 2009. He has served as guest editor for Sensors, TIMC, Journal of automous robotics, Journal of Healthcare Engineering, associate editor of Mechtroncis, General Chair of IEEE-NANO2019, IEEE-CYBER2017, Organizing Chair of IEEE-CYBER 2015, as organizing committee member of IROS2019, IROS2018, IEEE-NANO2015, IEEE-ICRA 2014, IEEE-IROS 2009 and so on. He has been elected as the vice president of IEEE Robotics and Automation Society for the term of 2018-2019.

Keynote Talk 11
Sunday, April 14, 2019, 10:45 - 11:10
Thai Chakkraphat 1, 2/F
Chair: Yunlong ZI, The Chinese University of Hong Kong

Precise Robotic SCNT to Increase Development Potential of Cloned Animal

Xin ZHAO

Institute of Robotics and Automatic Information System,

Nankai University

ABSTRACT

The somatic cell nuclear transfer (SCNT), also known as animal clone, is one of most complex and challenging cell manipulation tasks. The SCNT involves multiple manipulation procedures, such as oocyte rotation, penetration, enucleation, and somatic cell injection, and inevitably causes intracellular damage to recipient oocytes during manipulation, resulting in only around 1-2% of reconstructed embryos developed into live cloned animals. The low success rate has become the major obstacle to extensive applications of the SCNT. To address this problem, we measured the oocyte mechanical properties automatically and then utilized them to reduce the mechanical damage to cell in rotation and enucleation. Then, the automated polar body detection and nuclei visualization techniques were developed to perform precise enucleation through reducing the amount of lost cytoplasm in enucleation. Further, a robotic SCNT system was established and applied to pig cloning. We did thousands of robotic SCNT operations and transferred 510 reconstructed embryos to 6 pigs, and obtained 17 cloned pigs at last. Compared to manual SCNT methods, the blastocyst rate of our system was improved from 10% to 21%, the clone success rate was improved from 1-2% to 3.3%.

BIOGRAPHY

Xin Zhao is Chair Professor, Nakai University, Tianjin China. He received the B.S. degree from Nankai University, Tianjin, P.R.China, in 1991, the M.S. degree from Shenyang Institute of Automation, CAS, Shenyang, P.R.China, in 1994 , and the Ph.D. degree from Nankai University, in 1997, all in control theory and control engineering. He joined the faculty at Nankai University, Tianjin, P.R.China in 1997. He was a Visiting Professor in Center of Cell Control, Dept. of Mechanical & Aerospace Engineering, University of California at Los Angeles in 2009-2010. His research interests are in Mico-Nano Manipulation and System and Mathematical Biology. Prof. Zhao was the recipient of 1999 Excellent Professor Award, Nankai University, 2000 Inventory Prize, Tianjin Municipal Government, 2002 Excellent Professor Award of “College Key Teachers Fund”, Ministry of Education, 2002 Excellent Professor Award of “Baogang Fund” and 2007 Program for New Century Excellent Talents in University, Ministry of Education. His team was supported by High Level Innovation Team in Tianjin Special Support Plan for Talents Development and Tianjin Key Areas Innovation Team (2017). His team conducted the first batch of robotic-operated alive cloned animals around the world in 2017 and received the Award of China's 10 Advancements in Intelligent Manufacturing Science and Technology in 2018.

Keynote Talk 12
Sunday, April 14, 2019, 10:45 - 11:10
Thai Chakkraphat 2, 2/F
Chair: King Wai Chiu LAI, City University of Hong Kong

Towards Integrated Nanorobotic Systems

Lixin DONG

Department of Biomedical Engineering,

City University of Hong Kong

ABSTRACT

Since our demonstration on remotely actuated and controlled artificial bacterial flagella (ABF) in 2007, it has been used as agents for biomanipulation, carriers for drug delivery, and so on. A verity of designs, chemical functionalization, driving strategies, motion tracking, and control strategies have been investigated by so far; heralding the great potential in the approaching era of noninvasive surgery using these micro-/nanorobotic agents. However, one barrier yet to be adequately addressed is the physical functionalization by integrating these carriers with even smaller elements such as wireless energy transmitters, sensors, actuators, and tools at the nanometer scale for diagnosis and surgery. Microrobotic agents provided an ideal platform with an overall size at the micrometer scale to integrate nanoelements onto them. Artificial bacterial flagella are a particularly suitable platform due to their strain-engineering processes: 2D parented systems can be rolled up into 3D free-standing structures based on pre-stressed hetero thin films.

This talk will briefly review our recent efforts on these topics. We have demonstrated a group of segmented nanomaterial/structure based nanodevices including piconewton force/sub-nanometer position sensors and bacterial sensors based on inter-shell/layer/pod electron tunneling in carbon nanotubes, graphene, and pea-pod nanowires, passive oxygen sensors based on nanowire/film memristors, optical antennas based on helices, sphere-on-a-pillar and other plasmonic designs. These devices are featured with sub-10-nm down to atomic thickness, particularly adaptive to be integrated with ABF or other microrobotic agents. The integrated systems will enable cellular or sub-cellular scale in-situ sensing/diagnosis and noninvasive surgery such as thermal treatment based on wireless energy transformation.

BIOGRAPHY

Lixin Dong is a Professor at City University of Hong Kong. He received his Ph.D. degree in Micro Systems Engineering from Nagoya University in 2003 and became Assistant Professor there in the same year. Prior to join City University of Hong Kong, he has been an Associate Professor at Michigan State University by 2019 where he had been the founder and director of NanoRobotic Systems Lab. He held a Senior Research Scientist at ETH Zurich by 2008, where he had led the NanoRobotics Group in the Institute of Robotics and Intelligent Systems (IRIS) between 2004 and 2008. His main research interests include nanorobotics, nanoelectromechanical systems (NEMS), and enabling nanomanufacturing technologies for fluidic, photonic, and biomedical nanosystems. He introduced 3D nanorobotic manipulation under a scanning electron microscope in 2000, demonstrated nanorobotic spot welding under a transmission electron microscope in 2007, co-

invented artificial bacteria flagella in 2007, and showed nanotube fountain pens for directly writing nanoscale metallic structures in 2011.

He received the National Science Foundation Faculty Early Career Development (CAREER) Award in 2011 for intelligent nanorobotic end-effectors, the IEEE T-ASE Googol Best New Application Paper Award in 2007 for nanotube linear servo motors, and some 30 other awards. He serves as Vice President for Conferences, IEEE Nanotechnology Council, a Senior Editor of the IEEE Transactions on Nanotechnology and Chair of the Technical Committee (TC) on Nano Energy, Environment and Safety (NEES), IEEE Nanotechnology Council (NTC), a representative of IEEE Robotics and Automation Society in IEEE NTC AdCom, and a representative of IEEE Trans. on Nanotechnology in the Publication Activities Board (PAB), IEEE Robotics and Automation Society.

IEEE-NEMS 2019 Conference Program

April 11-14, 2019

Bangkok Marriott Marquis Queen's Park, Bangkok, Thailand

April 11, 2019 (Thursday)	
14:00 - 18:00	Registration at **Lobby Concierge**
18:00 - 20:00	Welcome Reception at **Pool House, 4/F** (for all registered attendees)

April 12, 2019 (Friday)

		Thai Chitlada Ballroom 1, 2/F			
8:40 - 8:50	Registration at **Pre-function Area, 2/F**	Opening Ceremony			
8:50 - 9:25		Plenary Talk 1 **Prof. Jürgen BRUGGER**			
9:25 - 10:00		Plenary Talk 2 **Prof. Norman Chihnan TIEN**			
10:00 - 10:20		Coffee Break			
		Thai Chakkraphat 1, 2/F		**Thai Chakkraphat 2, 2/F**	
10:20 - 10:45		Keynote 1 **Prof. Sheng XU**		Keynote 2 **Prof. Shang-Hsiu HU**	
10:45 - 11:10		Keynote 3 **Prof. Inkyu PARK**		Keynote 4 **Prof. Shinichiro NOMURA**	
		Thai Chakkraphat 1, 2/F	**Thai Chakkraphat 2, 2/F**	**Thai Boromphimarn 3, 3/F**	**Thai Boromphimarn 4, 3/F**
11:10 - 12:40		FrA1: Invited Session - MEM/NEMS Fabrication and Sensors ID: 103, 102, 92, 69	FrB1: Invited Session - Microfluidics for cell analysis ID: 2, 24, 28, 30, 81	FrC1: Flexible Devices ID: 183, 193, 231, 229	FrD1: Best Conference Paper Award Finalist ID: 6, 64, 88, 123, 54*
12:40 - 14:00		Lunch at **Goji Kitchen & Bar, Lobby** (for all registered attendees)			
14:00 - 15:30		FrA2: Invited Session - Soft M/NEMS and Smart Devices ID: 111, 29, 45, 112, 113	FrB2: Invited Session - Nonlinear MENS and NEMS ID: 35, 33, 23, 39	FrC2: Nanoelectronics and Circuit ID: 249, 178, 182, 175	FrD2: Best Student Paper Award Finalist ID: 90, 95, 129, 135, 82*, 152*
15:30 - 16:30		Coffee Break			
		FrPo1: Poster Session 1 ID: 9, 18, 37, 41, 47, 49, 50, 55, 56, 63, 68, 75, 77, 78, 94, 116, 128, 134, 137, 138, 145, 147, 156, 158			Pre-function Area, 2/F .
16:30 - 18:00		FrA3: Digital Microfluidics ID: 168, 256, 200	FrB3: Nanomaterials 1 ID: 255, 224, 234, 266, 242	FrC3: Nano Energy ID: 190, 213, 140, 253	FrD3:CM HO Best Paper Award in Micro/Nano Fluidics Finalist ID: 85, 91*, 143*
18:00-21:00		Organizers Dinner			

April 13, 2019 (Saturday)

		Thai Chitlada Ballroom 1, 2/F				
8:50 - 9:25	Registration at **Pre-function Area, 2/F**	Plenary Talk 3 **Prof. Fumihito ARAI**				
9:25 - 10:00		Plenary Talk 4 **Prof. Yu SUN**				
10:00 - 10:20		Coffee Break				
		Thai Chakkraphat 1, 2/F			**Thai Chakkraphat 2, 2/F**	
10:20 - 10:45		Keynote 5 **Prof. Zuankai WANG**			Keynote 6 **Prof. Haixia (Alice) ZHANG**	
10:45 - 11:10		Keynote 7 **Prof. Jr-Hau HE**			Keynote 8 **Prof. Xiaoning JIANG**	
		Thai Chakkraphat 1, 2/F	**Thai Chakkraphat 2, 2/F**	**Thai Chakkraphat 3, 2/F**	**Thai Boromphimarn 3, 3/F**	**Thai Boromphimarn 4, 3/F**
11:10 - 12:40		SaA1: Invited Session - Smart Sensor ID: 14, 13, 7, 4, 5	SaB1: Invited Session - Nano Energy and Smart Systems ID: 76, 44, 34, 31	SaC1: Invited Session - Micro-nanotechnology for diagnostics and therapeutics ID: 79, 22, 15, 101, 42	SaD1: Nanobiology and Medicine ID: 238, 214, 236, 233, 237	SaE1: Micro/Nano Fluidics ID: 11, 20, 66, 207, 132
12:40 - 14:00		Lunch at **Sala Thai Ballroom, 5/F** (for all registered attendees)				
14:00 - 15:30		SaA2: Invited Session - Scalable Nano-manufacturing ID: 126, 151, 127, 144, 160	SaB2: Invited Session - Nano-generator and Self-Powered Systems ID: 122, 118, 117, 110, 115	SaC2: Nanomaterials 2 ID: 189, 173, 250, 257	SaD2: Sensors and Actuators ID: 136, 235, 149, 217, 51, 8	
15:30 - 16:30		SaPo1: Poster Session 2 ID: 12, 61, 71, 84, 93, 96, 130, 131, 139, 141, 146, 154, 155, 202, 208, 222, 223, 226, 251, 167				Pre-function Area, 2/F .

April 14, 2019 (Sunday)

		Thai Chitlada Ballroom 1, 2/F			
8:50 - 9:25	Registration at **Pre-function Area, 2/F**	Plenary Talk 5 **Prof. Fabrizio LOMBARDI**			
9:25 - 10:00		Plenary Talk 6 **Prof. Wei WANG**			
10:00 - 10:20		Coffee Break			
		Thai Chakkraphat 1, 2/F		**Thai Chakkraphat 2, 2/F**	
10:20 - 10:45		Keynote 9 **Prof. Raymond LAM**		Keynote 10 **Prof. Lianqing LIU,**	
10:45 - 11:10		Keynote 11 **Prof. Xin ZHAO**		Keynote 12 **Prof. Lixin DONG**	
		Thai Chakkraphat 1, 2/F	**Thai Chakkraphat 2, 2/F**	**Thai Boromphimarn 3, 3/F**	**Thai Boromphimarn 4, 3/F**
11:10 - 12:40		SuA1: Invited Session - Advanced Microfluidics Manipulation and Fabrication for Biomedical Applications ID: 108, 120, 124, 133, 114	SuB1: Invited Session - Sensors actuators and Human-Computer ID: 46, 48, 119, 65, 80, 25	SuC1: Invited Session - Bioeletronics in clinical diagnostics ID: 19, 3, 10, 105	SuD1: Micro, Nano, and Molecular Fabrication ID: 70, 150, 177, 211, 58
12:40 - 14:00		Lunch at **Sala Thai Ballroom, 5/F** (for all registered attendees)			
14:00 - 15:30		SuA2: Invited Session - Sub-cellular and single cells analysis ID: 40, 109, 32, 209, 27	SuB2: Invited Session - Nanotechnologies for Engineering Living Systems ID: 261, 267, 268, 263,264	SuC2: Invited Session - Bioeletronics in clinical diagnostics ID: 21, 62, 159, 164, 269, 270	SuD2: MEMS/NEMS ID: 67, 259, 60
15:30 - 16:30		Coffee Break			
		Poster Session 3 ID: 162, 163, 180, 184, 187, 194, 195, 197, 198, 204, 205, 206, 218, 219, 220, 221, 239, 241, 243, 245, 254, 258, 262, 265			Pre-function Area, 2/F .
		Thai Chitlada Ballroom 1, 2/F			
16:30 - 17:15		Plenary Talk 7 **Prof. Zhong Lin WANG**			
17:15 - 17:45		Award Ceremony			
18:00-20:00		Farewell Party at **Thai Chitlada Ballroom 3, 2/F** (for all registered attendees)			

Invited Sessions

Invited Sessions

FrA1 MEM/NEMS Fabrication and Sensors

Session Chair: Zhouqing Yang
11:10 - 12:40, Friday, April 12 (Room: Thai Chakkraphat 1, 2/F)

FrA1.1 Towards Ubiquitous Applications of Wireless Sensors for Biotelemetry and MedTech Innovation

Jian LU, National Inst. of Adv. Industrial Sci. and Tech. (AIST)

In recent years, the dramatic progress in diagnostic techniques, along with the explosive growth of smart sensing technologies, wireless communications, and artificial intelligence (AI) inaugurated a new era in biotelemetry to deal with population aging and other social problems. Especially for disease prevention and disease diagnosis in early stages, implantable device is believed extraordinary important since it may accumulate more accurate data from inside the body with less affection by surrounding environments and wearing methods. However, great efforts are necessary for its ubiquitous applications in biotelemetry and MedTech innovation, including low power smart sensors, system scale down, bio-compatible packages, dis-assembly and recycle techniques, etc. In this paper, we will present our recent related works and progress on development and evaluation of ultra-compact and low power wireless sensor nodes from application point-of-view. The animal experiments by using mouse and cow indicated the potentials of those devices and future works. Moreover, a surgical navigation system by using artificial magnetic fields and 3D MEMS magnetic sensor nodes will be presented herein, which aiming at high-resolution real time tracking of human organs during organ excision or tumor care in medical operations.

……

FrA1.2 Exploiting Nonlinear Effects in Micromechanical Resonators for Sensor Applications

Xueyong Wei, Xi'An Jiaotong Univ.

Single crystal silicon micromechanical resonators have been widely studied due to their advantages compared with those made of quartz crystals in sensing, timing, and filtering applications. For example, doubly clamped beam micro resonators are widely used in resonant sensors and oscillators due to their structural simplicity. As the beam stretches, nonlinear behavior is readily observed at large vibrating amplitudes. The resonance frequency of a nonlinear micromechanical resonator has a dependence on its modal amplitude known as A-f effect, which is used for frequency tuning through changing the modal amplitude. The other vibration modes, however, can also be triggered as the amplitude of main mode reaches a certain level and accordingly strong nonlinear behavior like amplitude saturation can be observed. Traditionally, the nonlinear behavior of micromechanical resonators is purposely avoided in the design or cancelled in the real applications. However, the research shows that the nonlinear behavior can also be employed to realize certain functions for improving the performance of micro devices for frequency reference and timing purpose. Here, we will present our recent work on exploiting nonlinear effects in micromechanical resonators for sensor applications

……

FrA1.3 Bio-inspired flow and pressure sensors for intelligent control

Yonggang Jiang, Beihang Univ.

Fish, bird and insects have developed highly sensitive and robust flow and pressure sensors for flow field perception, which gives meaningful inspirations to intelligent control of micro air vehicles and underwater robots. Bio-inspired sensors were found to be the most promising for complementing or replacing current inertial-based reactive attitude sensors. This talk will give two specific examples to demonstrate the bio-inspired flow and pressure sensors, i.e., one is artificial lateral line sensors based on piezoelectric nanofibers, and the other is hair-type airflow sensors based on printed graphene/polyimide nanocomposites. Lastly, the integration of pressure and flow sensors in the altitude control system will be discussed.

……

FrA1.4 Dynamical modelling of the linear magnetic micro-actuator

gao xiang, Shanghai Univ. of Eng. Sci.
miao xiaodan, Shanghai Univ. of Eng. Sci.

A planar coil - type MEMS driver is designed in this paper. The main structure consists of a top elastic platform and the bottom micro electromagnetic driving system. The upper platform is including cantilever beam, central platform and permanent magnet. The bottom micro electromagnetic driving system is including coil, substrate and energizing contact. The planar coil on the silicon substrate generates a magnetic field when it is energized, and the size of the electromagnetic force can be controlled by changing the current in the control coil. Therefore, the attractive elastic platform can overcome the elastic restoring force of the cantilever beam, and move to the bottom until contacting with the bottom. Because of a permanent magnet, the connection state will be maintained until a reverse current is applied to offset the magnetic effect and the driver returns to disconnection. Finally, the bi-stable control of the driver can be realized.

……

FrB1 Microfluidics for Cell Analysis

Session Chair: Weiqiang Chen
11:10 - 12:40, Friday, April 12 (Room: Thai Chakkraphat 2, 2/F)

FrB1.1 Integrated Microfluidic Probes: Open-Space Microfluidic Systems for Cell Separation, Manipulation, and Analysis

Ayoola T. Brimmo, NYUAD
Ayoub Glia, NYUAD
Mohammad A. Qasaimeh, New York Univ. Abu Dhabi

The microfluidic probe (MFP) is an open space microfluidic technology that combine the concepts of hydrodynamic flow confinement (HFC) and scanning probes. The MFP functions as a vertical probe with injection and aspiration apertures operating in a push-pull configuration while it is positioned a few micrometers above an immersed substrate. The main advantage of the technology is that it overcomes the closed channel restrictions of conventional microfluidic devices. Moreover, given that the MFP is mobile with respect to the sample, it can work in the scanning mode for precise patterning applications with a large span of processing area and a high degree of flexibility. In biomedical sciences, these key features make the MFP a good candidate for performing bioassays in a similar manner to conventional applications in petri dishes. However, the MFP's potential outside biochemical stimulations of cells and tissue slices has been barely explored. This can be partly attributed to the fact that several configurations of the MFPs cannot be easily produced on demand, mainly, due to their typically complex photolithography-based microfabrication procedures. Recently, we demonstrated the use of 3D printing as a rapid, easy, and viable approach for fabricating MFPs. Using 3D printed MFPs, we formed microfluidic dipoles and quadrupoles, characterized their flow footprints, integrated MFPs with inbuilt reservoirs and micro-to-macro worlds interfaces, and showed how 3D printing offers flexibility in developing MFPs with different configurations. Currently, we are developing advanced MFPs that are integrated with other technologies and targeting applications in

cell separation, rare cell isolation, and single cell electroporation. The first example is a dielectrophoresis (DEP) based single cell sorter using microelectrodes fabricated on the tip of an MFP. Multiple hump-shaped elements, staggered between the injection and aspiration apertures, were designed into the tip of the MFP and made conductive by gold sputtering. Preliminary results showed good efficiency in cell separation, and demonstrated the first controllable electrical cell manipulation within open microfluidic setup. The second example is an MFP integrated with herringbone features for micro-mixing. The MFP's flat tip was designed with 2 slitted apertures -- one for injecting cell suspension and the other for performing high flow rate aspiration that guarantees formation of the HFC. The herringbone elements were distributed in-between the apertures for the formation of micro-eddies, to enhance rare cells capture on the functionalized antibodies-coated bottom substrate. Unlike the conventional closed herringbone chips, the bottom substrate of the MFP based herringbone has a larger surface area to minimize the propensity for saturation with captured cells. The MFP can also operate in the scanning mode to further increase capture area. Capturing rare cells in an open microfluidic system also allow for easy integration of downstream analysis such as single cell drug testing and atomic force microscopy based mechano-phenotyping studies. The last example being developed is the micro-electro-fluidic probe (MeFP) for single cell electroporation. The setup constitutes of the MeFP and an ITO coated glass slide that represents the bottom substrate. The MeFP is a gold coated MFP with a single pin shaped microelectrode integrated on the center of its tip. By culturing cells on the ITO coated glass slide, and placing the pin shaped microelectrode a few micrometers a top of the target cell, single cells electroporation can be performed. The setup allows for a selective exposure of the targeted cell to both the electric field and chemical perfusion of reagent, for enhanced selectivity and specificity.

……

FrB1.2 Nanofluidic Arrays Allowing High-throughput Detection and Manipulation of Single Nanoparticles and Extracellular Vesicles

Yan Xu, Osaka Prefecture Univ.

Current understanding of nanoscale transport and knowledge of physics, biology, and materials science allow us to envision new mechanisms and novel techniques to achieve fast, high throughput detection and manipulation of individual nanoscale objects—whether biological or nonbiological entities—with superhigh spatial–temporal resolution, rather than masses of all at once. To reach this goal, the considerable development of technology is required. Nanofluidic technology is of course necessary. This should come as no surprise, considering that the dimensions of nanochannels approach the dimensions of many biological and nanoscale objects of interest in a wide range of disciplines [1]. A significant growth of research in nanofluidics is achieved over the past decade, but the field is still facing considerable challenges toward the transition from the current physics-centered stage to the next applicationoriented stage. To conquer these challenges, we established a technology called "nano-in-nano integration", which allows the integration of a variety of functional components in nanofluidic channels. The nano-in-nano integration technology opens up a new arena to exploit chemistry, biology, and materials science at femtoliter, attoliter, single nanoparticles, and single molecule scales through nanofluidics [2-8]. Owing to the nano-in-nano integration technology, a new nanfluidic array device called aL-in-fL Array (aifA) was developed by us. The use of aifA allows the arraying, detection and manipulation of single nanoparticles in liquid phase, which has been greatly challenging in a wide range of nanoparticle-related fields. In addition, the use of aifA enabled the isolation and detection of single exosomes. Exosomes, which are a kind of nanoscale extracellular vesicles, promise great potential for non-invasive disease diagnosis and next-generation drug delivery systems. However, their R&D has been greatly hindered due to significant technical challenges in the isolation and analysis of exosomes. The aifA would be a powerful tools for studies and applications of exosomes because it provides a simple and efficient way to isolate, manipulate, detect and characterize single exosomes from cell culture supernatant or body fluids.

……

FrB1.3 Modeling the Leukemic Tumor Microenvironment on a Microfluidic Chip

Weiqiang Chen, New York Univ.

B-cell acute lymphoblastic leukemia (B-ALL) is one of the most prevalent pediatric cancers, characterized by the overproduction of dysfunctional and immature lymphoblasts in bone marrow (BM). Recent studies have shown that disrupting endothelial cell (EC)-derived CXCL12 signaling results in ALL apoptosis in vivo, and interactions with mesenchymal stromal cells (MSCs) in BM confer ALL leukemia chemo-resistance, highlighting the crucial role of the BM niche in leukemia progression and therapy resistance. To reconstruct leukemia-BM niche interactions, we developed a 3D microfluidics-based organotypic microsystem capable of monitoring real-time and controllable cell interactions (e.g. leukemic cells, ECs, and MSCs). We reported cell dynamics at different time points for three days by measuring migration speed and distance and immunostaining cells to determine the contribution of the CXCL12/CXCR4 signaling axis. We found that leukemic cells were recruited into the vascular network and promote EC sprouting during the three-day culture. Further, we administered AMD3100, a CXCR4 antagonist, and found that it significantly deterred impeded leukemia progression, confirming CXCL12/CXCR4 axis as a crucial role in regulating the leukemia-BM interactions. In summary, we observed that ECs and MSCs formed a vascular network in BM, providing a supportive niche for B-ALL leukemia survival via CXCL12/CXCR4 signaling.

……

FrB1.4 Engineering Nanoplasmonic Materials for Optofluidic Biosensors for Personalized Medicine

Wen Yang, Auburn Univ.
Jiacheng He, Auburn Univ.
Yuxin Cai, Auburn Univ.
Bryan A. Chin, Auburn Univ.
Pengyu Chen, Auburn Univ.

A novel approach based on the nanoplasmon ruler has been established to achieve direct visualization of the dynamic intercellular communication process in the immune system. Such a novel approach will establish a new paradigm that permits, for the first time, the direct visualization of the dynamic intercellular communication process in the immune system. The knowledge obtained from this study will facilitate a more comprehensive understanding of the immune intercellular network, unlocking the potential to transform the experimental studies into an information-rich science not only in immunology but beyond

……

FrB1.5 Micromixing-Enhanced Biosensing of Radioactivity Using Modified Deinococcus Radiodurans in Microfluidics

Raymond H. W. Lam, City Univ. of Hong Kong

α-radiation is extremely harmful if inhaled or swallowed, as it can be easily cause carcinogenetic or other physiological diseases. Here, we develop a microfluidic radiation biosensing device based on the β-galactosidase generation of genetically modified bacteria Deinococcus Radiodurans PZ0423 (DRPZ423) upon exposure of the radiation. An electrokinetic bacteria trapper is configured to locally aggregate bacteria to enhance the sensitivity. Additionally, a micro-thick transparent silicone membrane (<20 μm) has been applied to contain the sensing bacteria with only an radiation reduction of <5 %. Moreover, a micro mixer was further integrated to shorten the sensing time and reduce the loss of p-aminophenol. Altogether, this work has demonstrated a novel

microfluidic radiation biosensing technique for achieving reliable α-radiation monitoring.

……

FrA2 Soft M/NEMS and Smart Devices

Session Chair: XiaoSheng Zhang
14:00 - 15:30, Friday, April 12 (Room: Thai Chakkraphat 1, 2/F)

FrA2.1 Mild methods to engineer functional micro and nano systems

Juergen Brugger, Ecole Polytechnique Fédérale de Lausanne

The manufacturing of silicon-based micro and nano systems today is well advanced because the microelectro-mechanical devices for automotive, domestic, health-care and consumer electronics can befabricated with methods from IC industry. Polymer-based MEMS have a great potential for flexibleelectronics and biomedical applications and considerable progress has been made in process andintegration technologies for such demanding applications. But we must admit that up to now thetechniques to engineer functional polymers into reliable 3D microsystems for daily use are still at theirbeginning and not yet mature for cost-efficient and reliable manufacturing. One reason for that is that a standardized fabrication platform with theappropriate tools and processes does not yet exist. The field however begins to benefit from increasedefforts in soft and polymer materials applications. Additive manufacturing, (e.g. 3D printing) andassociated processing (e.g. sintering) have already started to transform traditional industry, and muchmore is expected in the near future. These novel approaches however are difficult to scale below amicrometer because the thermal processing is done in bulk or on surfaces by using furnaces or lasers, respectively. Both approaches are not scalable to the sub-micrometer. This paper will provide an overview of recent achievements in advanced manufacturing at themicro/nanoscale and associated key techniques.

……

FrA2.2 Dissoluble Microneedle patch for transdermal medical applications -DDS and painless health monitoring

Kai Takeuchi, The Univ. of Tokyo
Beomjoon Kim, The Univ. of Tokyo

New transdermal drug delivery system by using dissoluble micro needle patch will be introduced. With the development of the micro-scale engineering, microneedles show the potential to be the next generation delivery system. The microneedle mediated drug delivery system has been developed to provide painless self-administration of biological drug with patient friendly manner. Especially, dissolving microneedles, which deliver the target drugs as the drug-loaded microneedle dissolves into the skin, have been spotlighted recently. We investigate a novel fabrication method to achieve the user-friendliest, low-cost, and safest way for dissoluble microneedle patches with vaccine delivery.

……

FrA2.3 Self-powered Medical Electronic Devices

Zhou Li, Beijing Inst. of Nanoenergy and Nanosystems

Recently, piezoelectric and triboelectric nanogenerator have attracted much attention and been considered as another potential solution for harvesting mechanical energy. With its high output performance, outstanding biocompatibility and low cost, nanogenerator has been studied for powering implantable medical electronic devices. Here, we demonstrated an in vivo biomechanical-energy harvesting using a NG. An implantable triboelectric nanogenerator in a living animal has been developed to harvest energy from its periodic breathing. The energy generated from breathing and body moving was used to power a prototype pacemaker and a low-level laser cure system, respectively. It was found that the self-powered system could regulate the heart rate of a rat and significantly accelerated the mouse embryonic osteoblasts' proliferation and differentiation. Real-time acquisition and wireless transmission of self-powered cardiac monitoring data was demonstrated for the first time. It showed broad clinical applications of implantable self-powered medical systems for disease detection and health care. These works are concentrated on live-powered implantable medical devices. The NGs can convert the mechanical energy from human motion into electricity and drive the implanted long-term self-powered medical devices or biosensors. These are significant progress for fabricating implantable self-powered medical electronic devices using NGs as a power source and an active sensor.

……

FrA2.4 Engineered Flexible/Stretchable Sensors: From Fundamental Research to Applications

Ting Zhang, Suzhou Inst. of Nano-Tech and Nano-Bionics, CAS, China

Flexible and stretchable electronics are an exciting frontier for the next generation of wearable and portable electronic devices. In this talk, I will present our recent progresses of nanomaterials based high-performance flexible/stretchable/self-healing/transient sensing electronics. I'd like to discuss the important roles of the nanomaterials, device interface, and micro-structure design in achieving high flexibility and stretchability, and also the strategies to achieve high sensitivity, stability, and fast response time of the sensing devices. I will further show a facile and low-cost printing method for fabricating flexible sensors and sensor arrays, and demonstrate their applications in several areas such as robotic sensory skins, wearable health monitoring systems, bio-integrated devices, and human-machine interfaces, etc.

……

FrA2.5 Wetting and Marangoni Effect: Some perspectives and Applications

Cunjing Lv, Tsinghua Univ.

Interfacial phenomena resulted from the surface tension (especially accompanying with Marangoni effect) have great importance in both nature and industrial processes. Extensive research has been devoted to understanding the role of interfacial phenomena in particle transport and manipulation, medicine synthesis, flow instabilities and anti-wetting materials development. In this talk, I will try to shed some light on the understanding of wetting phenomena and the Marangoni effect at the solid-liquid-vapor interfaces by presenting several subjects in our recent work: monostable nano-/micro structured superrepellent materials,dropwise condensation and spontaneous dewetting of small droplets on superhydrophobic surfaces; trapping and manipulation of nano-/micro particles and biomaterials using light-actuated Marangoni tweezer (LAMT); Marangoni effect in confined space. These studies facilitate to acquire ideas to a number of follow-up studies, such as opening up new avenues for the large-area manipulation and patterning of very small objects, achieving new insights to interfacial hydrodynamics in optofluidics and nano-/microfluidics, as well as strategies to fabricate and optimize smart anti-wetting materials.

……

FrB2 Nonlinear MENS and NEMS

Session Chair: Xueyong Wei
14:00 - 15:30, Friday, April 12 (Room: Thai Chakkraphat 2, 2/F)

FrB2.1 Nonlinearity in Silicon Lateral Bulk Mode Micromechanical Resonators: Modeling, Characterization and Cancellation

Haoshen Zhu, South China Univ. of Tech.
Joshua Lee, City Univ. of Hong Kong

Single-crystal silicon (SCS) has been recognized as being an excellent mechanical material, based on which micromechanical resonators (i.e. micro-resonators) with quality factors (Q) in the order of 100000 to 1000000 have been demonstrated. Given such high Qs, SCS micro-resonators have been of interest in realizing high-performance fully-integrated oscillators with small form factors. For high-end applications with more stringent requirements on the phase noise (PN) performance, the nonlinearity of the micro-resonators is critical in setting the limit on the PN. This contribution describes previous efforts in modeling, characterizing and finally cancelling nonlinearity in lateral bulk mode micro-resonators possessing Qs in the order of 100000 to 1000000.

……

FrB2.2 Performance Improvement of MEMS Resonant Accelerometer utilizing Nonlinear Noise Modulation Effects

Xudong Zou, Inst. of Electronics, CAS

As one of the earliest commercialized MEMS products, MEMS accelerometer has been widely used in airbags, cameras, mobile phones and wearable devices. Recently, the micro-IMU integrated with 3-axis MEMS accelerometers and gyroscopes are highly demanded by autonomous vehicle, industrial robots and smart weapons. However, the conventional MEMS accelerometers using capacitive or piezo resistance sensing mechanism can hardly reach the resolution and long-term bias stability requirements for self-contained navigation and guidance system. Moreover, the seismometry and microgravity measurements for oil exploration and earthquake prediction even require the nano-g level accelerometer with minimized size, weight and cost. Silicon resonant accelerometer is believed as one of the candidates for the high-precision accelerometer due to the high sensitivity, direct digital output and mechanical robustness. As the core sensing element in MEMS resonant accelerometer, the frequency and amplitude noise and stability of the resonator is critical to the sensor's performance. To improve the noise and stability of both amplitude and frequency in a MEMS resonator system, one approach is to improve the output amplitude level. However, nonlinearities can arise from the large vibrational amplitudes and nearly all the resonator structures configured as sensors are designed to operate in the linear region. So, people may unconsciously to avoid making the resonator operated nonlinearly. In this talk, on the contrary, our work demonstrated as compared with the linear case, orders of magnitude improvement in amplitude and frequency signal resolution can be observed at the nonlinear bifurcation points where the electrical and mechanical nonlinear effects on the single or coupled beam resonators mixed. The resonator nonlinear behaviors, noise and stability optimization methods and the interface circuit for nonlinear resonator close-loop control will also be discussed.

……

FrB2.3 Nonlinear Dynamics of Bistable MEMS Structures and Applications in Sensors

Jian Zhao, Dalian Univ. of Tech.

Bistable compliant mechanisms have been widely used as functional spring elements due to their excellent characteristics of threshold snap-through, accurate positioning and state holding capability without external force, which have great applications in switches, relays, actuators, energy harvesting systems, memories, and micro accelerometer. Achieving namely bistable mechanics is the first step, the most important one lies in the bistability analysis and design for different applications. In our research group, the nonlinear bistable/multistable mechanics have been theoretically analyzed, and a series of bistability design methods have been proposed based on structure optimization technology. Especially, the possible buckling modes and their transforming procedure during the snap-through procedure were numerically obtained, which interprets reasonably the discontinuity of the force-displacement curve (also named sharp point) and multiple snap-through pathways. Then, the mechanism of snapping from one stable position to the other one is revealed according to the quality factor, geometric parameters, actuation force and its location, thus providing an effective way to design bistable mechanisms with high stability. Furthermore, a new type of nonlinear sensors and the corresponding dynamic models are proposed by utilizing the compressed bistable bifurcation phenomena, which can measure numerous, discrete and tailorable masses, acceleration and environmental variations.

……

FrB2.4 Synchronized Resonator Sensors

Dong F. Wang, MEMS LAB, Jilin Univ.
Cao Xia, MEMS LAB, Jilin Univ.
Shenglai Wan, MEMS LAB, Jilin Univ.
Xu Du, MEMS LAB, Jilin Univ.
Guowen Zheng, MEMS LAB, Jilin Univ.
Haonan Feng, MEMS LAB, Jilin Univ.
Xin Wang, MEMS LAB, Jilin Univ.

Synchronization of coupled systems is a common phenomenon in both nature and biological physiology. Some more thorough comprehensions are obtained from the view point of frequency multiplication in frequencies entrainment, as well as its potential applications to picogram mass sensing, pressure detecting, and friction force measuring. In mechanically coupled resonator systems, an improved phase noise is observed with the frequency multiplication. It is found that enhancing the nonlinearity without increasing the energy loss seems to be helpful in widening the frequency entrainment range. While in magnetically coupled resonator systems, a lowered phase noise is also observed for the first time with the frequency multiplication. Since the coupling strength can be easily changed, it has a promising potential use in IOT sensing network. Experimental demonstrations of synchronized oscillation used for picogram mass sensing, pressure detecting, as well as friction force measuring are achieved for the first time respectively, which elicit the possibility of increasing the sensitivity via phase-locking in synchronized resonator sensors.

……

SaA1 Smart Sensor

Session Chair: Jr-Hau He
11:10 - 12:40, Saturday, April 13 (Room: Thai Chakkraphat 1, 2/F)

SaA1.1 An overview of biosensor nanomaterial deposition methods

Rafiq Ahmad, King Abdullah Univ. of Sci. and Tech. (KAUST)
JR-Hau He, King Abdullah Univ. of Sci. and Tech. (KAUST)
husam alshareef, King Abdullah Univ. of Sci. and Tech. (KAUST)
khaled Nabil salama, King Abdullah Univ. of Sci. and Tech. (KAUST)

The biosensor development strategy includes deposition/attachment of nanomaterials on a conductive electrode surface, which is a crucial step for getting improved performances of the constructed biosensors. Different methods have been used to make a successful matrix of

nanomaterials, ensuring the proper contact between material and electrode surface. The purpose of nanomaterial deposition/attachment is to provide the high surface area that improves the electroanalytical performance of biosensors by supporting the stable immobilization of enzymes in more significant quantity and enhancing the catalytic or bioaffinity features.

……

SaA1.2 Fingertip Skin-Inspired Flexible Electronic Skins for Wearable Devices

Hyunhyub Ko, Ulsan National Inst. of Sci. and Tech. (UNIST)

Mimicking the structures and functions of fingertip skin, we introduce highly-sensitive, multifunctional, and flexible wearable sensors. We show that the interlocked microdome arrays possess highly direction-sensitive sensitive detection capability of various mechanical stimuli (normal, shear, stretching, bending, and twisting forces). Ferroelectric skins with fingerprint-like patterns can detect and discriminate multiple spatio-temporal tactile stimuli including static and dynamic pressure, vibration, surface texture, and temperature. In addition, we demonstrate a flexible ferroelectric sensor with ultrahigh pressure sensitivity and linear response over an exceptionally broad pressure range. Furthermore, hierarchical polymers with gradient elastic modulus exhibit highly sensitive triboelectric sensors capable of detecting human vital signs and voice. Our electronic skins can monitor hand gesture, artery pulse pressure, human breathing, and acoustic sound, suggesting potential applications in wearable healthcare monitoring devices and robotic skins.

……

SaA1.3 Low Power Smart Electronic Nose System Based on Three-dimensional Tin-oxide Nanotube Arrays

Zhiyong Fan, Hong Kong Univ. of Sci. and Tech.

Employing chemical gas sensor arrays in conjunction with classification algorithms, smart Electronic noses (E-noses) are able to detect and discriminate types and concentration of target gases. E-noses have triggered enormous interest globally because of their critical roles in gas leakage detection, indoor air quality and environmental safety monitoring. In this work we present realization of a high performance smart electronic nose (E-nose) system consisting of multiplexed tin dioxide (SnO2) nanotube sensor array, read-out circuit, wireless data transmission unit, mobile phone receiver and data processing application (App). Utilizing the unique nanotube sensor device structure in conjunction with multiple electrode materials, high sensitivity gas detection and discrimination has been achieved at room temperature. Therefore sensor power consumption has been reduced by 1,000 times as compared with a conventional device using thin film SnO2. The experimental results demonstrate that the developed E-nose can identify indoor target gases using a simple vector matching gas recognition algorithm. In addition, the fabricated E-nose has achieved state-of-art sensitivity for H2 detection and benzene detection at room temperature with metal oxide sensors. Such a smart E-nose system can address imperative need for distributed environmental monitoring in smart homes, smart buildings and smart cities.

……

SaA1.4 Wafer-Scale CVD Synthesis of WS2 for Flexible Photosensors

Changyong Lan, City Univ. of Hong Kong
Ziyao Zhou, City Univ. of Hong Kong
SenPo Yip, City Univ. of Hong Kong
Johnny C. Ho,

Wafer-scaled synthesis of 2D materials is vital for practical applications. In this paper, we reported wafer-scaled synthesis of monolayer WS2 by chemical vapor deposition (CVD) in a multi-zone horizontal furnace. The as-synthesized monolayer WS2 film has well crystallinity with good uniformity and exhibit good photosensing performance with a responsivity of 0.52 mA/W, a detectivity of 4.9×109 Jones, and a fast response speed shorter than 560 μs. When configured as flexible photosensors on polyimide substrate, the device showed enhanced performance with a responsivity of 5 mA/W and a detectivity of 3.9×1010 Jones though the response speed is reduced. Importantly, the photocurrent can retain 89% of the initial value after 3000 bending cycles, indicating the good flexibility of the monolayer WS2 based devices.

……

SaA1.5 Controlled encapsulation of guests into nanoporous materials for molecular selectivity

Chia-Kuang Tsung, Boston College

Towards our long-term vision of precisely controlling molecular selectivity for different applications such as catalysis and sensors, our group focuses on incorporating functional guests into crystalline nanoporous materials, metal-organic frameworks (MOFs). The precise molecularly-defined pores intrinsic to the MOFs provide a powerful tool to control the transformations of molecules in the systems. We have developed methods to encapsulate organic molecules, enzymes, and nanoparticles into MOFs and demonstrate great molecular selectivity.

……

SaB1 Nano Energy and Smart Systems

Session Chair: Yunlong Zi
11:10 - 12:40, Saturday, April 13 (Room: Thai Chakkraphat 2, 2/F)

SaB1.1 Electrostatic kinetic energy harvesters: from MEMS to TENG

Philippe Basset, Université Paris-Est

Electrostatic transduction is known for having a very favorable downscaling law and is commonly used in MEMS devices. With e-KEH, the energy of mechanical vibrations are converted into electrical energy by varying the charge in a capacitor, generally by varying the capacitance of an electromechanical transducer previously biased with a DC voltage. This initial bias can be provided by an external voltage source, an electret layer or successive triboelectric contacts. With Tribo-Electric Nano-Generator (TENG), the initial charging is based on charge transfer between materials covering the electrodes with different charge affinities: compared to electret-based MEMS e-KEHs, TENGs do not carry a pre-imposed charge with them. However, except for this fundamental difference, MEMS e-KEH and TENG are actually very similar devices. This talk will present recent MEMS e-KEH and TENG from Université Paris-Est and how a simple and practical Spice electromechanical model can be used for both of them. A comparison between basic conditioning circuits will be shown, including the Bennet doubler circuit that has the ability to self-increase the charge on the terminals of an e-KEH during its operation. Finally, an architecture for managing efficiently the high-voltages of such transducers will be presented.

……

SaB1.2 Piezoelectric Nano-Membranes Based Flexible Bio-Integrated Electronics for Biomedical Applications

Xinge Yu, City Univ. of Hong Kong

Flexible bio-integrated electronics have attracted great attentions due to the advantages of soft, lightweight, ultrathin architecture, and stretchable/bendable, thus has the potential to apply in various areas, especially in the field of biomedical engineering. By engineering the classes of materials processing and devices integration, the mechanical

properties of the flexible electronics can well match the soft biological tissues to enable measuring bio signals and monitoring human body health. Pb(Zr0.52Ti0.48)O3 (PZT) is an excellent piezoelectric material, and exhibits the capability for actuate sensing and actuation in electronics. Since PZT can not only precisely translate mechanical stress/strain to electrical signal, but also create local deformation by inputting electricity. However, the modulus of PZT is over 100 GPa, which is more than 6 orders of magnitudes greater than soft biological tissues. This mechanical mismatch between PZT and bio-tissues is the major challenge that limits its applications in flexible and bio-integrated electronics. In this presentation, the combined strategies in materials processing, mechanical design and device construction for architecturally engineered PZT based flexible biomedical electronics will be discussed. Demonstrations will include a flexible needle-shaped piezoelectric microsystem for tissue pathology biopsies (cancer diagnosis), and soft 3 dimensional microscale devices made from PZT based advanced electronics for bio-fluid measurement.

……

SaB1.3 On the mechanical, electrical, and material constraints against the piezoelectric energy harvesting improvement

Junrui Liang, ShanghaiTech Univ.

In this talk, we provide a comprehensive study on the mechanical, electrical, and material constraints against the PEH enhancement. The discussion starts with the current source model, which represents the simplest and most ideal case of a PEH system. By adding the practical features or conditions to the ideal model one by one, the influence of each practical constraint can be separately investigated. By discussing such practical constraints from all mechanical, electrical, and material aspects, we manage to clarify the existing difficulties in PEH systematically. On the other hand, such understanding might also give us some hints towards the future breakthroughs in either of the three aforementioned domains.

……

SaB1.4 Ingeniously Designed Electrode Materials for High-Performance Triboelectric Nanogenerator

Zhen Wen, Soochow Univ.

Triboelectric nanogenerator, a recently emerging technology that is based on the combination of triboelectric effect and electrostatic induction, has been found to be a promising strategy to harvest large amounts of underutilized and low-frequency mechanical energy and convert to electricity. The major challenge for TENGs is the practical application requires flexible, deformable, multifunctional materials to ensure its favorable accommodation to arbitrary surfaces or moving object or harsh environment. Our recent research interest mainly focuses on the design and fabrication of electrode materials for high performance multifunctional TENG, which exhibits good performances makes it the perfect candidate for wearable power source. In this presentation, I will firstly introduce the designed concept of flexible electrode for TENG. Then the different improvement parameters will be discussed. As main topics, I will present a couple of recent achievements regarding highly deformable TENG based on different kinds of electrodes, including geometrically designed rigid electrode, liquid electrode and 3D printed compressible electrode, etc. In addition, I will address a new concept of self-healable electrode based flexible TENG for potential implantable electronics. Finally, the recent research and design efforts for enhancing power generation performance of TENG by electron blocking layer will also be discussed in this talk.

……

SaC1 Micro-nanotechnology for diagnostics and therapeutics

Session Chair: Yi Zhang
11:10 - 12:40, Saturday, April 13 (Room: Thai Chakkraphat 3, 2/F)

SaC1.1 Application of Nanodiamonds for Drug-Delivery and Diagnostic Applications

Edward Chow, National Univ. Conference

We present here the use of detonation nanodiamonds (NDs) as a base nanomaterial for improving drug delivery and diagnostics. Particularly, in cancer, effective treatment and detection of cancer if often limited by the ability of therapeutics and diagnostic molecules to reach their desired location. Further complicating oncology therapy is that many of these drugs are often toxic and have severe adverse side effects. This also limits their dosages and effectiveness. The use of nanomaterials in biomedical applications offers the opportunity to improve both efficacy and safety of therapeutic and diagnostic molecules. We have demonstrated in a number of studies that nanodiamonds are a powerful tool for biomedical applications, particularly in their applications for both drug delivery and diagnostics.

……

SaC1.2 Apoptosis and Cell Arrest of Electric Field Treated Tumor Spheroids

Kin Fong Lei, Chang Gung Univ.

Alternating electric field with low-intensity (1-3 V/cm) and intermediate-frequency (100-300 kHz) was investigated to inhibit the proliferation of tumor spheroids in vitro. Human hepatocarcinoma cell line of Huh7 was used in this study. The cells were suspended in soft hydrogel and proliferated to form tumor spheroids. An alternating electric field was then applied via a pair of parallel plate electrodes during the culture course. Investigation of cell viability was conducted under various conditions of the electric field. The results showed that the electric field of 1.0 Vpp and frequency of 130 kHz could inhibit the proliferation of the tumor spheroids. More importantly, dissociation of the tumor spheroids was found after the electric field stimulation. In addition, the effectiveness of the anti-cancer drug was enhanced when the alternating electric field was simultaneously applied to the tumor spheroids. That indicated the alternating electric field could lower the drug dosage for the same treatment effectiveness. The combined treatment of alternating electric field and chemotherapeutic agent may be a prospective cancer therapy for hepatocellular carcinoma patients.

……

SaC1.3 Rapid Polymerase Chain Reaction Performing in Flow-Through Microfluidic Chip

Yen-Heng Lin, Chang Gung Univ.
Yin-Xiang Weng, Chang Gung Univ.
Chiuan-Chian Chiou, Chang Gung Univ.

Rapid PCR (<5 s per cycle) can help the molecular diagnosis in a very short time. The two key points of rapid PCR are the PCR reagents and the quick thermal response system. It has been reported that by increasing primer and polymerase concentrations in PCR reagent, the PCR can be shortened to several second per cycle without compromising in PCR efficiency and yield [1]. This may imply that the time required for PCR was limited by instrumentation. In addition, no commercially available instrument can provide such high temperature change rate. Microfluidic technology provides several unique advantages including low thermal capacity and low reagent consumption. In this study, we used continuous-flow design with high heat transfer rate to achieve a rapid PCR within 4 s per PCR cycle.

……

SaC1.4 Smart Hydrogel Microfluidics for Single-Cell Analysis

Noe Hsu Myat, NUS
Chia-Hung Chen, NUS

Secreted proteins determine a range of cellular functionalities correlated with human health and disease progression. Because of cell heterogeneity, it is essential to measure low abundant protein secretions from individual cells to determine single-cell activities. In this study, an integrated platform consisting of smart hydrogel immunosensors for the sensitive detection of single-cell secretions was developed. A single cell and smart hydrogel microparticles were encapsulated within a droplet. After incubation, target secreted proteins from the cell were captured in the smart hydrogel particle for immunoassay. The temperature-induced volume phase transition of the hydrogel biosensor allowed the concentration of analytes within the gel matrix to increase, enabling high-sensitivity measurements.

……

SaC1.5 Extraction and Isolation of Mitochondria from Biological Samples via Microfluidics

Megan Yi-Ping Ho, The Chinese Univ. of Hong Kong

We develop a novel approach to rapidly extract and isolate mitochondria from samples of clinically relevant sizes. While currently available methods are mostly laborious and not suitable for small-scale analyses in the clinics, the proposed approach is able to handle 200 microliters of sample and process the mitochondrial isolation within 30 minutes. Aside from the possibility for small-scale analysis, the proposed microfluidic approach offers many distinct features, including the simple procedures, undemanding equipment request, minimal damages to the isolated mitochondria, and continuous batch processing. Possibilities to analyze mitochondria from a limited amount of clinically relevant patient samples are expected to expand our knowledge towards the basic biological mechanisms of mitochondrial function, and to elucidate how mitochondria are involved in the development of diseases such as cancers, premature aging syndromes, diabetes and neurodegenerative disorders. For instance, it becomes practical to obtain mitochondria from the patient samples, and to elucidate how defective mitochondria link to the mitochondria-associated diseases. Furthermore, the working principle may be tailored for an array of subcellular fractions, rendering more efficient identifications and characterizations of intracellular organelles of interest and, consequently, advancing the study of biology and medicine continuously.

……

SaA2 Scalable Nano-manufacturing

Session Chair: Huan Hu
14:00 - 15:30, Saturday, April 13 (Room: Thai Chakkraphat 1, 2/F)

SaA2.1 Desktop Fabrication of 2D and 3D Polymer Nanostructures with Scanning Probe Lithography

Zijian Zheng, The Hong Kong Polytechnic Univ.

Polymer nanostructures are very important for a wide range of fields spanning from electronic to biomedical researches. Conventionally, these nanostructures are fabricated via photolithography or electron beam lithography, which has a significant limitation on the choice of polymer and the access of the equipment by researchers. Recently, scanning probe lithography (SPL), a series of tip-based fabrication using a sharp scanning tip, has emerged as a powerful yet low-cost tool for nanofabrication. This talk will discuss how to develop SPL for patterning 2D and 3D polymer nanostructures. Two important strategies, including (1) the top-down direct transfer of polymer materials by polymer pen lithography (PPL) and (2) the bottom-up grown of polymer brushes via dip-pen nanodisplacement lithography (DNL), will be discussed in detail. Finally, we will introduce some latest development of large-area fabrication using tip-arrays, and their application in the control of cell activities such as cell adhesion and alignment.

……

SaA2.2 High-Resolution and Large-Area Patterning by Nanoimprint

Xing Cheng, Southern Univ. of Sci. and Tech.

Nanoimprint is a lithographic technique that can directly fabricate micro- and nanoscale structures in polymers with high resolution, low cost and high throughput. With those features, nanoimprint is regarded as the technique of choice for commercial production of nanostructures. In this talk, we discuss the key issues that are critical in advancing nanoimprint into industrial manufacturing, particularly the materials for nanoimprint templates and resists. We also discuss the importance of the mechanical properties of the nanostructures on defect generation during nanoimprint. Finally, we present several commercial applications of nanoimprint in the production of large area micro- and nanostructures for photonic and bioengineering applications.

……

SaA2.3 Effect of PID Parameters on Machining Outcomes Using AFM Tip-based Nanomilling approach

Yanquan Geng, Harbin Inst. of Tech.
Jiqiang Wang, Harbin Inst. of Tech.
Yongda Yan, Harbin Inst. of Tech.
Hao Li, Harbin Inst. of Tech.

In this study, atomic force microcopy (AFM) tip-based nanomilling approach is employed to fabricate nanogrooves on a poly (methacrylate) (PMMA) surface. The normal load applied by the probe is kept constant during the machining process using the optical lever feedback closed-loop. The Proportion Integration Differentiation (PID) parameters have a large influence on the response time of the force-feedback closed-loop. The effects of the proportional and integral gains on the machining results are studied in detail. Results show that the depth and width of the machined grooves are obviously different when machining with different PID parameters. In addition, the various uncut chip thickness in one scratching cycle for the nanomilling process leads to the change of the machined depth in width direction of the grooves and the requirement of adjusting piezoelectric tube (PZT) of the AFM system to keep the normal load constant. This can result in the nanomilling process is more sensitive to PID parameters. Finally, the optimized PID parameters is selected to guarantee the machining consistency of the nanogrooves, which may have the potential to drive the application of this machining technique.

……

SaA2.4 Top-down nanomanufacturing using nano-apertures and bottom-up nanomanufacturing using metal-assisted chemical etching

Huan Hu, ZJU-UIUC Inst., International Campus, Zhejiang Univ.

Scalable nanomanufacturing is the key technology to enable the application of many exciting nanotechnology such as self-cleaned surfaces, anti-bacterial surfaces, meta-materials, etc. In this talk, I will show two approaches that are promising in manufacturing nanotextured surfaces in a low-cost and scalable fashion. The first method belongs to top-down approach and is based on a nano-aperture array that allows light to go through tiny apertures that are smaller than the wavelength of light to produce patterns that are also smaller than the wavelength of light, beating the diffraction limit of light in lithography. Two methods of producing these nano-apertures will be presented and large-area of vertical silicon nanowires are produced by this method.

The second method belongs to bottom-up approach and is based on metal-assisted chemical etching that uses silver nitrate and hydrofluoric acid to produce silicon nanostructures such as nanospikes in short etching time and nanowires in longer etching time. Optimized etching conditions are found to produce silicon nanospikes that can kill bacteria such as E. Coli by geometry, a recently-discovered phenomenon of killing bacteria in wings of insects such as cicadas and dragonflies.

……

SaA2.5 Interference Lithography and Nanoimprint Lithography for Nanooptic Devices over Wafer-scale Area

Wen-Di Li, The Univ. of Hong Kong

Deterministic fabrication of nanoscale structures over large area is crucial to practical applications of nanooptic devices, including plasmonic sensors, optical metamaterials and metasurface, structural color displays, just to name a few. Large-area fabrication of 1-D and 2-D gratings with sub-micron features is also important to many fundamental science and defense applications. This presentation will introduce our effort on developing innovative reconfigurable interference lithography techniques to create periodic gratings and pillar/hole array over wafer-scale area. Periodic lines and dots with sub-50 nm feature size and sub-200 nm pitch are achieved. Combined with nanoimprint lithography and a series of nanofabrication processing, elementary patterns like lines and dots can be converted into more complex nanoscale structures that can play versatile functions. In addition to demonstrating large-area uniform nanopatterning, we will also showcase our deterministic fabrication of gradient nanostructures with feature sizes varying continuously with spatial position. Enabled by the advanced nanofabrication techniques, wafer-scale nanooptic devices have been developed as ultraviolet light filters, surface-enhanced spectroscopic sensors, gradient colorimetric sensors, etc.

……

SaB2 Nano-generator and Self-Powered Systems

Session Chair: Yunlong Zi
14:00 - 15:30, Saturday, April 13 (Room: Thai Chakkraphat 2, 2/F)

SaB2.1 Hybridized triboelectric nanogenerators and energy storage devices

Ya Yang, Beijing Inst. of Nanoenergy and Nanosystems, CAS, China

A hybridized electromagnetic-triboelectric nanogenerator is to utilize electromagnetic and triboelectric nanogenerators to simultaneously scavenge mechanical energy from one mechanical motion. As compared with the individual energy harvesting unit, the hybridized nanogenerator has much larger output power, higher conversion efficiency so that it can be used to solve the power source issue of some devices with larger power consumption. The hybridized nanogenerators have the potential applications in self-powered sensors, wearable devices, and networks. Rapid advancements in various energy harvesters impose the challenge on integrating them into one device structure with synergetic effects for full use of the available energies from our environments. We report a multi-effects coupled nanogenerator based on ferroelectric barium titanate, promoting the ability to simultaneously scavenging thermal, solar, and mechanical energies. By integration of a pyroelectric nanogenerator, a photovoltaic cell and a triboelectric-piezoelectric nanogenerator in one structure with only two electrodes, multi-effects interact with each other to alter the electric output, and a complementary power source with peak current of ~ 1.5 μA, platform voltage of ~ 6 V and peak voltage of ~ 7 V is successfully achieved. Compared with traditional hybridized nanogenerators with stacked architectures, the one-structure-based multi-effects coupled nanogenerator is smaller, simpler and less costly, showing prospective in practical applications and represents a new trend of all-in-one multiple energy scavenging.

……

SaB2.2 Ultralight Triboelectric Nanogenerators for Portable Self-charging Power Unit and Self-powered Sensing Platform

Min-Hsin Yeh, National Taiwan Univ. of Sci. and Tech.

With rapid development of portable electronic devices and systems, mandatory requirements of portable, lightweight, and significantly sustainable power sources have attracted huge attention. The crucial problem of batteries is their limited lifetime and thus their need to be charged or replaced frequently. To conquer this problem, self-powered systems as integrated by an energy harvester and an energy storage device has been proposed and developed to simultaneously harvest and store ambient energy in the form of electricity. Here, we report a ultralight cut-paper-based self-charging power unit (PC-SCPU) that is capable of simultaneously harvesting and storing energy from body movement by combining a paper-based triboelectric nanogenerator (TENG) and a supercapacitor (SC), respectively. PC-SCPU is demonstrated as a sustainable power source for driving wearable and portable electronic devices such as a wireless remote control. To further enhance the output performance of TENG for extending the possible applications in portable electronic devices, we also report an ultrahigh output power of whirligig-inspired TENG (Wi-TENG) designed according to an antiqueue whirligig toy that is capable of converting low-frequency pulling motion into a high-frequency rotation. After power management, this Wi-TENG is successfully demonstrated as a portable sustainable power source for driving a commercial blood glucose meter.

……

SaB2.3 Energy Harvesting by Triboelectric Nanognerators for Self-Powered Sensing Systems

Guang Zhu, Beijing Inst. of Nanoenergy and Nanosystems
Zhong Lin Wang, Beijing Inst. of Nanoenergy and Nanosystems

Converting ambient mechanical energy into electricity provides a viable solution to a sustained power source for distributed small electronic devices. It is particularly significant for the development of wireless sensor networks. In the past five years, we innovatively utilized contract electrification on the surface of flexible thin-film nanomaterials, proposing a novel mechanism for the conversion of mechanical energy. This so-called triboelectric nanogenerator has a considerable advantage in terms of high energy density. Based on this mechanism, we tuned the processes of triboelectric charge generation as well as free electron transporting frequency and direction. As a result, a family of high-performance miniaturized triboelectric nanogenerators was developed. These devices could convert and harvest diverse types of mechanical motions, such as human body and water wave movement. Upon energy storage and management, the generated electricity could provide maintenance-free power supply for diverse types small sensors. The self-powered sensing systems are promising to be widely used in on-site diagnosis, security surveillance, and Internet of Things.

……

SaB2.4 Super-Stretchable and Mechanically-Durable Triboelectric Nanogenerators for Soft Power Suppliers, Self-Powered Electronic Skins, and Soft Robots

Ying-Chih Lai, National Chung Hsing Univ.

Deformable devices have attracted great interest because they cannot only extend the scope of smart systems but also provide compliant user experience. Operating those devices inevitably need power sources. However, traditional batteries suffer from heavy weight, bulky volume, and limited capacity and lifetime, hindering the progress of those devices. Here, super-stretchable and mechanically-durable triboelectric nanogenerators will be demonstrated. The device realized through

composed of intrinsic stretchable components can generate electricity from contact with other materials regardless of various extreme deformation required from uses, such as extreme stretch of over 300% strain, and multiple twists and folds. Particularly, even experiencing severe tearing damages, the device can retain its functionality. With the perfect flexibility, the device can be fully conformal on various nonplanar or irregular objects to act as power sources for other components. The device can also be introduced into fabric materials for wearable energy and fabric-based self-powered sensing uses. Furthermore, a pressure-sensitive structure will be designed on the device for the use of stretchable self-powered robotic sensing skins. Last, various kinds of actively perceiving and responsive soft robotics will be demonstrated by using the devices. These works can open the crucial doors for wearable/stretchable/deformable electronics, electronic skins, and soft robots.

……

SaB2.5 The self-powered nanosystem based on dielectric elastomer and triboelectric nanogenerator

Xiangyu Chen, Beijing Inst. of Nanoenergy and Nanosystems

In recent years, the triboelectric nanogenerator based on the contact-electrification phenomenon and nano-micro manufacturing technology has become a hot research topic in the field of energy harvesting system. By directly applying the output voltage from a single-electrode triboelectric nanogenerator (TENG) to the dielectric elastomer (DE) films, we have demonstrated a novel self-powered TENG-DEA system to provide controllable and notable actuation motion. Meanwhile, the same DE materials can be applied to fabricate an elastic TENG that can serve as the skin-like sensor on human body. This elastic TENG can even work on the human fingers without disturbing body movement, while it can detect the skin deformation and contact motion. We can establish a fully elastic and metal free system to promote many potential applications in the field of wearable self-powered sensory system, electronics skin, artificial muscles and soft robotics. Together with the self-powered capability of TENG, this actuation system could also potentially be used as a self-powered soft robotic or driving element in the Micro-Electro-Mechanical System.

……

SuA1 Advanced Microfluidics Manipulation and Fabrication for Biomedical Applications

Session Chair: Nien-Tsu Huang
11:10 - 12:40, Sunday, April 14 (Room: Thai Chakkraphat 1, 2/F)

SuA1.1 A Rapid Antibiotic Susceptibility Test of Blood-Borne Pathogen using Microwell Device integrating Surface-enhanced Raman Scattering Sensing

Nien-Tsu Huang, National Taiwan Univ.
Hsiu-Kang Huang, National Taiwan Univ.

Sepsis is a common serious bacterial infection disease. Without early-stage diagnosis followd by prompt management, sepsis can easily lead to multiple organ failure and eventually death. Currently, more than 30 million people worldwide are diagnosed with sepsis and 6 million people died each year. In clinic, antibiotic susceptibility test (AST) is commonly used in antibiotic treatment for patients. However, due to the low bacterial concentration of clinical sample, conventional AST usually takes 1-3 days bacterial cultivation to reach the detection limit. Such long cultivation time may increase the mortality of serious infected patients. To address this problem, we propose a rapid, parallel and label-free microfluidic platform for on-chip bacterial confinement and detection using microwell device and surface-enhanced Raman scattering (SERS) sensing, respectively. To eliminate the prolonged cultivation process, a microwell device was used to increase the initial sample concentration by confining one or few bacteria in pico-volume wells. For bacteria detection, SERS is a highly sensitive and label-free technology which can identify various bacteria species and understand antibiotic susceptibility by analyzing secreted bacteria metabolites. In summary, we hope this microfluidic platform could achieve multiplex and label-free bacteria detection and AST to provide rapid and accurate sepsis treatment.

……

SuA1.2 Autonomous microfluidic control for periodic sequential flow applications

Sung-Jin Kim, Konkuk Univ.

Recently, microfluidic chips are becoming increasingly sophisticated, integrating increasingly larger numbers of microfluidic components for high throughput biochemical analysis. The cost associated with the external control units to operate the microfluidic components is large because even single external pressure control units such as a pump is relatively expensive. With increased recognition of this control-challenge that hampers broader use of microfluidic chips for high throughput and high complexity analysis, microfluidic engineers are searching new ways to enable sophisticated on-chip control without increasing the number of large external controllers. One way to minimize the external control units is to preprogram the operation of the microfluidic devices and operate them without external controllers. Here, we exploit electric hydraulic analogy for the preprogrammed function of the microfluidic chips. We implement microfluidic devices analogous to electronic circuits and the devices autonomously perform periodic, sequential control of solutions for cellular rhythm study, plasma extraction, sputum homogenization, generation of aqueous two-phase system droplet, dynamic cell staining, and arm actuation.

……

SuA1.3 Dielectrophoresis based manipulation of biological entities in microfluidic devices

Bobby Mathew, UAE Univ.

Dielectrophoresis has been widely employed in microfluidic devices for manipulation of biological entities for purposes of focusing and separation. Dielectrophoresis is attractive as it scales well with miniaturization and requires neither sheath flow nor specialized wafers for its implementation. Dielectrophoresis provides an alternative to actuation mechanisms that rely just on size or biological properties for purposes of manipulation to achieve high performance metrics. One of the key aspects of successfully implementing dielectrophoresis in microfluidic devices is electrode configuration; working of microfluidic devices with several planar and non-planar electrode configurations have been demonstrated in literature. This presentation will discuss the fundaments of dielectrophoresis and its application in manipulation of biological entities for purposes focusing and separation using a planar electrode configuration.

……

SuA1.4 Detoxification Process of Microchips for Biomedical Devices Fabricated by Microstereolithography

Yoshinori Inoue, Univ. of Tokyo
Koji Ikuta, Univ. of Tokyo

Microstereolithography was a one of the micro fabrication methods which could make arbitrary shape including micro channels, micro chambers, microreactors and so on. But photo curable polymer had not applied for biomedical microfluidics devices because it had cytotoxic character even if it had solidified. To overcome this problem, we developed a method of detoxification for photo curable polymer after microstereolithography. We fabricated cell culture wells by microstereolithography. When PC12 cells were cultured in culture wells that were baked at 223 degrees Celsius for 24 hours using an oven, cell

activity equivalent to that of commercial cell culture wells was confirmed. In addition, when gas generated during the postbake process was recovered, we found it had cytotoxicity due to the cell culture test. It was confirmed that this postbake process reduced cytotoxicity by sublimation diffusion from the inside of the well. Therefore, we revealed that cell culture could be realized inside a stereolithography cell culture chip with a design with all wall thickness thinned.

……

SuA1.5 Low-Damage-Plasma Modification on Graphene for Gas-Detection Applications

Chih-Ting Lin, Naitonal Taiwan Univ.
Ming-Shiu Tsai, National Taiwan Univ.
Chun-Hsuan Lin, National Taiwan Univ.
Wei-Tong Chen, National Taiwan Univ.
Chi-Hsien Huang, Ming Chi Univ. of Tech.
Wei-Yen Woon, National Central Univ.

Because of the outstanding properties of graphene, it has been researched for potential applications. One of the major applications is gas sensing for low-power, high sensitivity, and high selectivity. Its sensing mechanism could be resulted from electrical conductivity (σ) changes, which is due to adsorbed target molecules acting as donors or acceptors to graphene. Based on this idea, in this talk, a low-damage plasma treatment is introduced to have a reliable and controllable modification of an artificial-stacked-graphene-bilayer (ASGB). The low-damage plasma modifies ASGB surface without degrading graphene structure. It offers less bombardment damage and better controllability of modification of graphene. As a consequence, the developed sensing material was examined by Raman, XPS, and surface contact-angle measurements. Based on the experimental results, both sensitivity and selectivity can be enhanced. This can be attributed to the enhancement of physical adsorption and π-electrons modification on graphene surface. In addition, the power consumption of the modified ASGB sensing device is examined as hundreds of mW, which is also an advantage of applications. Therefore, this work demonstrates a reliable method for graphene-based sensing materials and paves the way for potential graphene applications.

……

SuB1 Sensors Actuators and Human-Computer

Session Chair: Yuliang Zhao
11:10 - 12:40, Sunday, April 14 (Room: Thai Chakkraphat 2, 2/F)

SuB1.1 Magnetic Propelled and Navigation of Micro-/Nanorobots

Tianlong Li, Harbin Inst. of Tech.

Because of their capability of remote actuation and navigation, magnetic field can be widely used in the field of drug delivery, biosensing and bioimaging. Here we report a new type of magnetic nanorobot, a symmetric multilinked two-arm nanoswimmer, capable of efficient"freestyle" swimming at low Reynolds numbers. These two-arm nanorobots are capable of a powerful propulsion up to 12 body lengths per second, along with on-demand speed regulation and remote navigation. Designing autonomous and adaptive control systems for operating micro/nanorobotics in complex and dynamically changing environments, which is a highly demanding feature, is still an unmet challenge. Here we also describe a smart microrobot for precise autonomous magnetic navigation in complicated environments and traffic scenarios. This autonomous navigation system can guide the vehicle movement in complex patterns, in thepresence of dynamically changing obstacles, and in complex biological environments. Such a magnetic navigation system for micro/nanoscale vehicles, relying on vision-based close-loop control and path planning, is highly promising for their autonomousoperation in complex dynamic settings and unpredictable scenarios expected in a variety of realistic nanoscale scenarios.

……

SuB1.2 High-brightness and Roll-Off Free Pure Blue Organic Light-Emitting Diodes with Inverted Configuration

Jiajie Liu, School of Mechatronic Eng. and Automation, Shanghai Univ.
Kangping Liu, Key Lab. of Adv. Display and System Applications, Ministry of Education, Shanghai Univ.
Kunping Guo, Key Lab. of Adv. Display and System Applications, Ministry of Education, Shanghai Univ.
Bin Wei, School of Mechatronic Eng. and Automation, Shanghai Univ.
Yan Peng, School of Mechatronic Eng. and Automation, Shanghai Univ.

Blue organic light-emitting diodes (OLEDs) are of significant importance for full-color display, lighting and excitation sources. For example, recent advances in imaging techniques have made it feasible to visualize biocomponents and bioprocesses by transforming the chemical and biological information into detectable signals. To facilitate high-quality fluorescence imaging, high-quality blue excitation source are needed without damaging in Vitro cell under irradiation by blue laser diode. To date, blue phosphorescent organic emitters are relatively rare compared with the large number of green or red phosphorescent emitters. In addition, the external quantum efficiency of pure blue OLEDs is not so high and they often exhibit a serious efficiency roll-off at high driving current density due to triplet-triplet annihilation. The high energy consumption, efficiency roll-off, and poor carrier injection are key issues limiting the commercialization of blue OLEDs. This presentation will discuss the fundamental challenges to the pure blue emission of fluorescent OLEDs, and present novel configuration to realize high-brightness and efficient blue OLEDs to overcome the challenges. Also, it will discuss the potential applications of blue OLEDs as excitation source in illumination and bioimaging.

……

SuB1.3 Paper Keyboard and Wireless IoT Motion Detection Rings for Human-Computer Interaction

Yuliang Zhao, Northeastern Univ. at Qinhuangdao

We proposed an ultralight wearable virtual keyboard that the users would not notice its existence when wearing it. Wearing two wireless IoT rings on the middle phalanges of two fingers of each hand, one can input the characters by typing in the air or on a desk without any other devices. These two rings can capture the gestures and motions of all fingers for the keystrokes recognition. This wireless IoT ring is mainly consisted by a BLE (Bluetooth Low Energy) unit, an IMU (Inertial Measurement Unit) sensors, and a button battery totally weighting only 7.8 grams. Attitude angle and the acceleration are adopted as the feature for keystroke recognition. The attitude angle of each finger is estimated by the angle compliment filter. After comparing different machine learning algorithms for keystroke recognition, the k-Nearest Neighbor (k-NN) show the best classification result. In the 100 times letter typing experiments for each subject, the overall keystroke recognition correct rate can reach to 94.8% when wearing just two IoT rings on each hand.

……

SuB1.4 Multi-functional Nano-Material Enabled Human-Machine Interactive Interfaces for Multi-dimensional Sensing

Shuo Gao, Beihang Univ.

Future human-machine interaction (HMI) technologies have two major expectations: multidimensional sensing and long battery lifetime. In terms of the former, the current main stream HMI technology-touchscreen panel (TSP), however, employs only single sensing

technique in a single device to detect one certain type of physical signal (one dimensional sensing). Thus, multiple devices with different sensing capabilities need to be embedded into one single system to allow multi-dimensional sensing. As for the latter expectation, i.e., long battery life, although the energy cost is tiny for individual touch sensor in a TSP, the total energy consumption is huge considering numerous touch panels are intensively utilized worldwide. Besides the product optimization design and progress in battery technique, which approaches a limit imposed by the current technology to reduce power consumption and boost battery's capability, harvesting the environmental energy is essential to enhance battery lifetime. It is very challenging to achieve the above goals by current techniques. However, the recent advances in material science provide a potential means to reach this. Thus, in this talk, the progress, future development trend and limitation of multi-functional materials based human-machine interfaces for multi-dimensional sensing will be discussed.

……

SuB1.5 3D printing methods and regulations for smart hydrogel structures

Runhuai Yang, Anhui Medical Univ.

Despite the promise and recent progress in hydrogels application, the fast and accurate additive manufacturing of different types of hydrogels into 3D architectures with specifically designed functions remains a challenge in the field of biomedical engineering. Our group built up experimental equipment for the fabrication of common hydrogels and smart hydrogels, for example, self-designed microextrusion 3D printers and digital light processing stereolithography system were built up. The print inks consisted of natural and synthetic hydrogels was studied with different gelling methods, and polymer with different functions was tested. We also developed some regulation methods for these printed hydrogels which control the mechanical properties and shape. Alginate hydrogel, PEG hydrogel, PEG/AAC hydrogel and PEGDA/NIPAAM hydrogel were printed by our systems for applications in pH sensitive and electric-regulated drug delivery and cell transportations. Different types of cells were cultured on our 3D printed materials, such as HEK 293T, COS 7, MSCs, etc. The cells were printed and cultured into difference structures, and the live/dead assay results show that the whole process was biocompatible and the cell viability is acceptable. This presentation will discuss the challenges to the biocompatibility, efficiency, accuracy of the hydrogel based 3D printing.

……

SuB1.6 Nonlinearity, Noise, and Dynamic Range in Two-Dimensional Nanoelectromechanical Resonators

Zenghui Wang, Univ. of Electronic Sci. and Tech. of China

The advent of low-dimensional nanostructures has enabled a plethora of new devices and systems. Among them, nanoelectromechanical systems (NEMS) offers the unique capability of coupling the exquisite material properties found in these atomically-defined nanostructures with their mechanical degree of freedom, opening new opportunities for exploring exotic phenomena at the nanoscale. In this talk I will discuss the theoretical and experimental study of nonlinearity, noise, and dynamic range in two-dimensional nanoelectromechanical resonators, and demonstrate that broad dynamic range can be achieved in such atomically-thin nanomechanical structures.

……

SuC1 Bioeletronics in Clinical Diagnostics

Session Chair: Kin Fong Lei

11:10 - 12:40, Sunday, April 14 (Room: Thai Boromphimarn 3, 3/F)

SuC1.1 Label free Impedimetric Immunosensors for Point of Care Diagnostics

Cheng Hsin Chuang, National Sun Yat-sen Univ.

Impedance based biosensors normally utilize the formation of a recognition complex between a bioreceptor (e.g. antibody) and its corresponding specific analyte (e.g. antigen) in a thin film configuration on the electrode surface. In our lab, we have developed novel impedimetric immunosensors for the point of care detection of two diseases, namely bladder cancer and chronic kidney disease. The immunosensor for bladder cancer detection utilizes a gold interdigitated microelectrode array and dielectrophoretically trapped nanoprobes (antibody-conjugated nanoparticles) with an achievable limit of detection in the pg/ml range. In addition, we have also developed a novel, inexpensive and disposable screen-printed immunosensor for the early detection of CKD, which is urgently needed as Taiwan has the highest incidence and prevalence rates of end stage renal disease in the world. To improve sensitivity, stability and antibody immobilization, the carbon working electrode surface is sequentially modified with polyaniline and gold nanocrystals, and shows a linear dependence on microalbuminuria concentration in the clinically relevant range. Furthermore, we have also designed a portable impedance analyzer that can analyze the data from these immunosensors and transfer it wirelessly for cloud computing, thus enabling real time improved public health monitoring.

……

SuC1.2 Thread-Based Microfluidic Device for Mass Spectrometry Detections of Pesticide and Food Ingredients

Che-Hsin Lin, National Sun Yat-sen Univ.

This research presents the first microfluidic chip which integrates capillary electrophoresis electrochemical (CE-EC) detection and electrospray ionization mass spectrometry (ESI-MS). It can be used for rapid bio- and food sample analysis. A polyester thread of 200 μm in diameter is used as the liquid route such that any delicate channel fabrication process can be avoided. In order to improve the efficiency of single thread-based CE separation, two buffer drops are placed on each side of the sample plug to shorten it, called the in-line sample "pinch focusing" process. A caffeine standard sample and the ingredients of the commercial energy drink Red Bull are detected with a high signal to noise ratio of more than 10. Finally, the combination of CE-EC detection and ESI is achieved by this single thread microfluidic system. Biosamples of dopamine and ascorbic acid, as well as a food sample of a sports drink Super Supau are both successfully detected, demonstrating the integration of these two methods. The combination of two detection methods allows more samples to be detected through an easier process, which shows great potential for bio and food applications.

……

SuC1.3 Three-Dimensional Organic Bioelectronics for Efficient Isolation, Detection, and Recovery of Circulating Tumor Cells

Yu-Sheng Hsiao, Ming Chi Univ. of Tech.

Circulating tumor cells (CTCs) comprise the high metastatic potential population of cancer cells in the blood circulation of humans; they have become the established biomarkers for cancer diagnosis, individualized cancer therapy, and cancer development. Technologies for the isolation and recovery of CTCs can be powerful cancer diagnostic tools for liquid biopsies, allowing the identification of malignancies and guiding cancer treatments for precision medicine. In this talk, I will introduce several

types of novel three-dimensional (3D) organic bioelectronic interfaces (OBEIs) studied by our group recently, including the vertical (out-of-plane) and horizontal (in-plane) nanostructure electrodes for rare circulating tumor cell (CTC) isolation, detection, and collection via an electrically triggered cell released from chips. Additionally, the 3D devices are demonstrated on the conducting polymer-based organic electrochemical transistors (OECTs), which can offer electrical signals for monitoring of prostate-specific antigen (PSA) in liquid biopsy or CTC-capture performance on chips. Evidence suggesting that this study opens an avenue of bioelectronic medicine for cancer diagnostics and therapeutics.

……

SuC1.4 The utilization of optically-induced-dielectrophoresis (ODEP) mechanism in microfluidic systems for circulating tumor cells (CTCs) studies

Min-Hsien Wu, Graduate Inst. of Biomedical Eng., Chang Gung Univ.

Circulating tumor cells (CTCs) are the rare cancer cell species present in the peripheral blood that are proven to be responsible for cancer metastasis. The fundamental studies of CTCs hold immense potentials for exploring the biological mechanisms underlying cancer metastasis, which could both facilitate and accelerate scientists to develop new therapeutic solutions for the future cancer care. In cancer care, moreover, the analysis of CTCs in a blood sample has been found clinically useful for the diagnosis of early cancer, evaluation of long-term cancer prognosis, or monitoring of cancer recurrence. Nevertheless, the CTC-relevant studies have been limited by the rarity of CTCs in a blood sample (e.g., approximate concentration of 1 CTC per 105-107 blood mononuclear cells) which makes CTCs technically-demanding to harvest. To tackle the technical hurdle, our group proposed to integrate optically induced dielectrophoretic (ODEP) force-based cell manipulation in a microfluidic system for high-performance CTC isolation and analysis. This presentation will discuss the current challenges in CTC studies, and our strategies to apply ODEP-based microfluidic systems for CTC (and also CTC cluster) separation, isolation, purification, and analysis.

……

SuA2 Sub-cellular and Single Ccells Analysis

Session Chair: Na Liu
14:00 - 15:30, Sunday, April 14 (Room: Thai Chakkraphat 1, 2/F)

SuA2.1 Quantifying Drug-induced Nano-mechanics and Mechanical Effects to Single Cardiomyocytes for Clinical Applications

Tao Yue, Shanghai Univ.

Cardiac physiological diseases are mainly initiated by chemical signals and physical or mechanical stimuli to the cardiomyocytes. Among such deleterious effects, one of the majorities is the cardiotoxicity from anticancer drugs. This research was focused on quantifying doxorubicin and dexrazoxane induced changes of mechanobiological properties on single cardiomyocytes, exploring direct evidences for revealing the therapeutic effectiveness of the drugs, contributing to optimize drug administration strategies for reducing cardiotoxicity. An integrated nano-instrumentation with a systematic approach was developed to quantitatively characterize the nano-mechanics of single cardiomyocytes under desired drug treatments. A direct correlation between drug effects and single cell nano-mechanics in a time-dose-dependent manner was demonstrated. The changes of single cell mechanics and mechanical properties were correlated with different drug administration sequences, and demonstrated the possibility to optimize the clinical drug administration strategies.

……

SuA2.2 Magnetic nanomaterials-mediated biological effects on cells

Jianfei Sun, Southeast Univ.

Due to good biocompatibility, remote controllability by magnetic field and protein-like property, magnetic nanoparticles get suitable to interact with cells. In this presentation, we will show some results about the manipulation of cells in past years and introduce some new developments in magnetic targeting of magnetic red cells. By assembly of magnetic nanoparticles, the adhesion, migration and differentiation of stem cells can be directed.

……

SuA2.3 Extracting Transcription Initiation Intermediate of Escherichia coli RNA Polymerase Revisited by Using Alternating-Laser Excitation- based Single-Molecule FRET Nanotechnology

Guangcun SHAN, Beihang Univ.
Wenwei Zheng, Arizona State Univ., Arizona

By labeling biomacromolecules with fluorophores that serve as donor–acceptor pairs for resonance energy transfer, based on alternating-laser excitation (ALEX) scheme to excite directly both donors and acceptors present in single diffusing molecules, the single-molecule FRET experiment was recently performed to study the sequence-specific interaction of E. coli catabolite activator protein (CAP) with DNA as a model for protein-nucleic acid interactions. To address the challenging issue of interactions at nanoscale, our group is developing single-molecule FRET nanotechnology for the programmable kinetics of RNA polymerase (RNAP) transcription initiation based on single-molecule FRET experiment. Since initiation is a highly regulated, rate-limiting step in transcription, this is accomplished with our novel technique of using alternating-laser excitation-based fluorescence-aided molecule sorting (ALEX-FAMS) that enables the precise controls and measurement over the placement and orientation of DNA and RNAP. This presentation will present our results showing that RNAP exit kinetics from complexes stalled at later stages of initiation were markedly slower than from earlier stages and also confirming the existence of a previously hypothesized paused and backtracked RNAP initiation intermediate, which may reflect a conserved state among paused, initiating eukaryotic RNA polymerase II enzymes. Furthermore, it will discuss the future promise of such intermediates for therapeutic purposes.

……

SuA2.4 High-throughput Mechanical Phenotyping of Androgen-Sensitive and Nonsensitive Prostate Cancer Cells Using a Real-time Deformability Cytometry

Panpan Du, Shanghai Univ.
Na Liu, Shanghai Univ.
Yuanyuan Liu, Shanghai Univ.
Tao Yue, Shanghai Univ.
Huayan Pu, Shanghai Univ.
Shaorong Xie, Shanghai Univ.

Cellular mechanical properties have been identified to characterize cells' pathologic states. Here, we report our work on high-throughput mechanical phenotyping of androgen-sensitive and nonsensitive human prostate cancer cells using a real-time deformability cytometry. The theory for extracting cells' elastic modulus from their deformation and area, and the used experimental parameters are analyzed. The mechanical properties of three types of prostate cancer cells lines with different sensitivity to androgen including LNCaP, DU145 and PC3 were quantified. The result shows that LNCaP cell is the softest, on the hell is the DU145, the PC3 is the stiffest.

……

SuA2.5 Neural Interface Based On Nanomaterials For Transfecting And Stimulating Neuron Cells

Wang Ying, Beihang Univ.

The physical and chemical properties of nanomaterials enabled the reaction of many biology interfaces that can be used to manipulate and control biological system at fundamental, molecular levels with a high degree of specificity. In this study, we describe a novel platform utilizing diamond nanoneedles arrays to facilitated efficient, reliable and vector-free cytosolic delivery. We show that our technique has the capability to deliver the broad range of molecules and materials into the cytoplasm of primary neuron in adherent culture. In particular, for delivering nuclear acids into neurons, our technique produces at least eightfold improvement (~45% versus ~1–5%) in transfection efficiency with a dramatically shorter experimental protocol. We also focus on developing a novel neural stimulation technique by using upconversion technology. In this study, Upconversion nanoparticles (UCNPs) were used as a transducer element to convert remotely applied NIR irradiation to visible light that reliably evoked neuronal spiking activity. The application of nanomaterials to neuroscience research has significantly expanded the toolbox for manipulating the complex nervous system at different levels, providing innovative neural interfaces that can achieve unprecedented temporal and spatial control over the system.

……

SuB2 Nanotechnologies for Engineering Living Systems

Session Chair: Jangho Kim
14:00 - 15:30, Sunday, April 14 (Room: Thai Chakkraphat 2, 2/F)

SuB2.1 Integrating Biologically Inspired Nanomaterials and Dynamic Culture Environments for Improved Differentiation of Human Mesenchymal Stem Cells

Ki-Taek Lim, Kangwon National Univ.

Human mesenchymal stem cells (hMSCs) are critical for numerous groundbreaking therapies in the field of regenerative medicine. Nanoscale topography of artificial substrates can greatly influence the fate of stem cells including adhesion, proliferation, and differentiation. Thus the design and manipulation of reduced graphene oxide (rGO)-based nanosheets and its electrical properties are of great importance to realize graphene-based electronics as a strategy in stem cells and tissue engineering applications. In this report, we propose that electro-conductive graphene oxide nanosheets with pulsed electromagnetic fields (PEMFs) are an efficient platform for modulating and enhancing structure and function of hMSCs. Using a self-assembly method, we successfully coated graphene oxide (GO) on glass for fabricating GO nanocomposite and had tunable electrical conductivity of graphene oxide sheets. Here we show that rGO with PEMFs as a graphene-based cell stimulator provides a promising biocompatible nanocomposite that does not hamper the proliferation of hMSCs and accelerates their specific differentiation into bone cells. Our bottom-up biomechatronic approach of tuning the rGO-sheet properties provides a path to a broad new class of graphene-based materials and their use in a variety of applications.

……

SuB2.2 Blood-Brain Barrier on a Chip: A Biomimicry of Brain Microvasculature Physiology

Hong Nam Kim, Korea Inst. of Sci. and Tech. (KIST)

The blood vessels in the brain play an important role in the maintenance of homeostasis by preventing the molecular transport from the blood stream to the brain tissue. Due to their filtering characteristics, the blood microvascular structure in brain tissue is termed 'blood-brain barrier'. Here, we present an engineered three-dimensional (3D) in vitro brain microvasculature system embedded within the bulk collagen matrix. To create a functional brain microvascular structure, we fabricated an array of microchannels in a bulk collagen I by using microneedles as templates. By attaching and culturing brain endothelial cells on the luminal surface of the cylindrical collagen microchannels, we reconstructed an array of engineered brain microvasculature with a circular cross-section. The transendothelial permeability was demonstrated by observing the efflux of FITC-dextran across the microvasculature and quantifying the amount of transported molecules with mathematically derived molecular transport models. The transendothelial permeability decreased significantly over 3 weeks of culture. According to the immunofluorescent staining, the decreasing trend of permeability was closely correlated with the maturation of tight junction between the cells. We also demonstrated the disruption of the barrier function with a hyperosmotic mannitol as well as the subsequent recovery of it over 4 days. Our brain microvasculature model in vitro, consisting of system-in-hydrogel can serve as a useful tool not only for fundamental studies associated with a blood-brain barrier in physiological and pathological settings but also for pharmaceutical applications.

……

SuB2.3 Designing nanosacle topographical structures for controlled morphology and function of cells

Jangho Kim, Chonnam National Univ.

Living tissues are complex ensembles of multiple cell types that are surrounded by a complex extracellular matrix (ECM) that provides well-defined nanoscale structures to regulate cellular morphology and function through biochemical and mechanical signals as well as for tissue regeneration. Therefore, engineering complex ECMs is one of the most important challenges to regenerate or replace complex and functional living tissues and organs in regenerative medicine. In this talk, I will present multidisciplinary efforts directed towards the development of nanoscale engineered biomimetic systems for biomedical applications. Specifically, I will talk about i) our current efforts on developing a series of nanoscale patterned platforms inspired by the unique architectures of native tissues and ECMs that can provide cells the in vivo-like topographical environments, and ii) their applications for better understanding of the function of living cells and tissue regeneration without complex surgical treatments or tissue transplantation in combination with traditional molecular and cell biology approaches.

……

SuB2.4 THz Spectroscopy for Bio/Nano Molecular Analyses

Haewook Han, Pohang Univ. of Sci. & Tech.

THz band (0.3-30 THz) is now becoming important in both science and technology, finding tremendous new opportunities in nanobiotechnology. At the most fundamental level, what distinguishes a spectral band from another is how the electromagnetic wave interacts with matter. THz photon energy (1-100 meV) is closely related with the intraband dynamics of solid-state materials such as semiconductors and quantum matters (graphene and topological insulators), and the intermolecular vibration dynamics of biomolecular systems, including water molecules. In this presentation, we present the recent advances in Nano-Bio THz Photonics Laboratory at POSTECH, including THz time-domain spectroscopy of biomolecular materials and THz spectroscopic near-field microscopy for quantitative bio/nano molecular analyses.

……

SuB2.5 Hybrid Nanocomposites in Bio/Nano Medicine

Jin-Woo Kim, Univ. of Arkansas

A variety of nanoscale materials, both hard and soft nanomaterials, with various shapes, sizes and compositions have proven effective as functional materials, offering immense promise to advance diverse fields, ranging from optics, electronics, and biomedicine to name a few. Recently, great interest has been focused on their promising attributes for manipulating into multifunctional hybrid nanostructured materials with tailored size, shape and functionality. This presentation will focus on the recent advances in the design, fabrication, and characterization of such biohybrid nanocomposites for advanced materials and devices particularly in bio/nano medicine. It will discuss the fundamental challenges to as well as future directions of the controlled assembly of nanocomposites with specific shape and function, and present our strategies to achieve the control and functionality necessary to overcome the hurdles. This work was supported in part by the National Science Foundation (CMMI-1235100 and OIA-1457888).

……

SuC2 Bioeletronics in Clinical Diagnostics

Session Chair: Kin Fong Lei

14:00 - 15:30, Sunday, April 14 (Room: Thai Boromphimarn 3, 3/F)

SuC2.1 Beyond Conventional Medicine with Micro/Nano Technology

Yi Zhang, Nanyang Technological Univ.

Conventional medicine relies on centralized diagnostics and generalized clinical intervention. My research aims to improve clinical outcomes through point-of-care diagnostics and personalized medicine that are enabled by micro/nanotechnology. I will first talk about magnetic digital microfluidics with novel surface features that enable a full-range of droplet manipulations and greatly extend its applicability in point-of-care molecular diagnostics and antimicrobial susceptibility. After that, I will show a novel method for the fabrication of nanostructured materials. I will demonstrate the application of a silica-based hierarchical nanostructured material fabricated using this method in the purification of high molecular weight DNA for third generation single molecule sequencing.

……

SuC2.2 A Creative Manufacturing Method to Fabricate Three-Dimensional and Hybrid Microfluidics

pin-chuan chen, National Taiwan Univ. of Sci. and Tech.

The use of three-dimensional (3D) printing for the fabrication of microfluidic chips has attracted considerable attention among researchers. This low-cost fabrication method allows for rapid prototyping and the creation of complex structures; however, these devices lack optical transparency, which greatly hinders the characterization and quantification of experiment results. In this study, we developed a fabrication method involving the solvent bonding of Poly(methyl methacrylate (PMMA) and Acrylonitrile Butadiene Styrene (ABS) thermoplastic materials for the creation of hybrid microfluidic chips. The benefits of the proposed method are as follows: (1) simplified fabrication of complex 3D microfluidic chips; (2) optical characterization and quantification of fabrication results; and (3) the ability to print and embed tubing connectors within the microfluidic chip to facilitate assembly. Two experiments were conducted to evaluate the efficacy of the proposed scheme, including a 3D split-and-recombine (SAR)-based passive micromixer, and an integrated microchip for the mixing of two streams of liquid prior to the formation of double-emulsion droplets. Our experiment results demonstrate the applicability of the proposed scheme in the fabrication of complex microfluidic chips quickly and easily, without sacrificing their intended functionality.

……

SuC2.3 Sensing Probe-Modified Graphene Field-Effect Transistors

King Lai, City Univ. of Hong Kong

Effective determination of food contaminations is important in the field of food safety and public health. Recently, sensing probe-modified graphene field-effect transistors (G-FETs) have been widely used for highly sensitive and selective detection of food contaminations. Understanding the interaction between the sensing probe and the target, interfacial carrier generation and transport in the target/sensing probe-modified-graphene system are the keys to improving sensing performance of G-FETs biosensors. In this talk, the biosensing using graphene field-effect transistors with the aid of pyrene-tagged DNA aptamers (APG-FETs), which exhibit excellent selectivity, affinity and stability for Escherichia coli (E. coli) detection. The aptamer is employed as the sensing probe due to its advantages such as high stability and high affinity toward small molecules and even whole cells. The change of the carrier density in the probe-modified graphene due to the attachment of E. coli is discussed theoretically for and also verified experimentally. The conformational change of the aptamer due to the binding of E. coli brings the negatively charged E. coli close to the graphene surface, increasing the hole carrier density efficiently in graphene and achieving electrical detection. The detection mechanism is ascribed to the E. coli induced electrostatic gating. The binding of negatively charged E. coli induces holes in graphene, which are pumped into the graphene channel from the contact electrodes. The carrier mobility, which correlates the gate voltage to the electrical signal of the APG-FETs, is analyzed and optimized here. Besides, the selectivity and stability of the APG-FETs for E. coli detection are investigated, and the excellent results pave the way to develop APG-FETs for bacterial detection.

……

SuC2.4 Micro-engineered liquid-liquid interfaces for assembly of macromolecules

Ho Cheung Shum, Univ. of Hong Kong

The submission is about micro-engineering aqueous liquid-liquid interfaces for directing the assembly of particles and macromolecules that leads to biomimetic behaviors and interesting dynamics. For details, please see the attached abstract.

……

SuC2.5 Miniaturized Analytical Devices for Point-of-Care Diagnosis

Chien-Yu Chen, National Taiwan Univ.

Healthcare issues are keeping increased substantially in recent years. Such research and investment have focused on fighting major diseases, enabled by the novel invention of efficient drug development for treatment and side effect reduction, along with the improved vector control. However, classic diagnostic technologies are not completely suited to meet the expanded testing requirement because they rely on complicated sample purification and sophisticated instruments which are complicated, time-consuming, expensive and requirement of well-trained technicians. In order to the improved efficiency in laboratory diagnostics, there has been a trend towards more decentralized diagnostics which occurs directly at patients' bedside, in outpatient clinics or at sites of accidents, so-called point-of-care (POC) systems. The concept of POC testing is mainly by the patient, so short turnaround time, minimum sample preparation, long-term reagent storage, user-friendly analytical instruments and visible quantitative or semi-quantitative single readout is crucial. In our research group, we address

the need using silicon, polymer and paper-based analytical platforms. They have been developed for biomedical sensing and analysis in resource-limited settings based on their advantages of low sample volume requirement, rapid detection, cost effectiveness, portable and highly integrated. Moreover, different sensing components, including device fabrication, surface chemistry, signal amplification and biomolecular recognition are also investigated.

……

SuC2.6 Artificial cilia: Current developments and future perspectives

Chia-Yuan Chen, National Cheng Kung Univ.

Microorganisms such as paramecia can manifest a variety set of mobility through the collaborative beating behaviors of cilia which provide a promising strategy in flow manipulation at microscale. Artificial cilia are developed accordingly to further explore the possibilities of dynamic transport of drugs/cells for precise point-of-care applications by mimicking the nature. In this presentation the working principles of artificial cilia will be first illustrated together with the related current development in the microfluidic regime. Practical applications will be given and scrutinized in the context of the hydrodynamic analysis and flow visualization to delve into the underlying physics towards precise control and functionality of artificial cilia. Key technical challenges with focuses on the perspectives of the design strategies including the device integration and the associated implementation to the biomedical devices will also be discussed with details. Throughout the talk the aim is to pave the road for building robust and tunable solutions to versatile tasks where artificial cilia actuation is necessary.

……

Regular Sessions

Regular Sessions

FrC1 Flexible Devices

Session Chair: Cheng-Hsin Chuang
11:10 - 12:40, Friday, April 12 (Room: Thai Boromphimarn 3, 3/F)

FrC1.1 Topological Design of Microchannel of a Liquid Metal based Super-stretchable Sensor

Qinwu Gao, Shenzhen Inst.s of Adv. Tech., CAS, China
Jinjie Zhang, Shenzhen Inst.s of Adv. Tech., CAS, China
Zhenwen Xie, Shenzhen Inst.s of Adv. Tech., CAS, China
Zebang Luo, Shenzhen Inst.s of Adv. Tech., CAS, China
Olatunji Omisore, Shenzhen Inst.s of Adv. Tech., CAS, China
Yousef Alhandarish, Shenzhen Inst.s of Adv. Tech., CAS, China
Lei Wang, Shenzhen Inst.s of Adv. Tech., CAS, China
Hui Li, Shenzhen Inst.s of Adv. Tech., CAS, China

A novel Eutectic Galium-Indium (EGaln) liquid-based microfluidic stretchable sensor is developed. It comprises an Ecoflex microfluidic assembly filled with EGaln, which serves as the working fluid of the stretchable sensor. The lithography method is applied to achieve microfluidic channel. The microfluidic channel is optimized by using topology method, making this device with high conformability and high stretchability. This method is applied to the fabrication of an elastomer-encapsulated strain gauge that displays an approximately linear behavior from 0 to 550% strain with a maximum gauge factor of 4.95. Detection of joints motions have been detected by the sensors, which shows great potential of a functional liquid-state device technology with superior mechanical flexibility and conformability in biomedical applications.

……

FrC1.2 Asymmetric Langmuir-Blodgett and Hydrophilization Process to Realize Density-Controllable Carbon Nanotube Array on Flexible and Stretchable Substrates

Qinghua Wang, Peking Univ. Shenzhen Graduate School
Qiuyue Huang, Peking Univ. Shenzhen Graduate School
Zhiqiang Liao, Peking Univ. Shenzhen Graduate School
Chunhui Du, Peking Univ. Shenzhen Graduate School
Min Zhang, Peking Univ. Shenzhen Graduate School

Well-aligned Carbon nanotube (CNT) arrays are very promising for application in flexible and stretchable devices. In this work, an improved LB method and a new hydrophilization method are combined together to achieve CNT arrays with controllable density on various flexible and stretchable substrates like Polyethylene naphthalate (PEN), polyimide (PI) and polydimethylsiloxane (PDMS) for the first time. The LB method is featured by multiple and asymmetrical compression-expansion cycles. By varying the target surface pressure, the nanotube density on PEN substrate can be rationally controlled. Besides, a new hydrophilization method by growing a SiO2 thin layer is proposed. After the treatment, the water contact angle on various organic substrates can be reduced significantly. This method can improve the performance and stability of flexible and stretchable devices. The change of equivalent resistance of CNT array film on PEN substrate is within 40% after bending 2000 times with a curvature radius of 4 mm, and it is within 20% on PI substrate.

……

FrC1.3 A Flexible Chemical Battery Chip Activated by Finger Pressure

JiaSheng Huang, Peking Univ.
Fengyi Zheng, Peking Univ.
Enqi He, Tsinghua Univ.
Xing Zhang, Peking Univ.
Zhihong Li, Peking Univ.

We proposed a flexible chemical battery applicable for wearable devices. We chose a zinc-copper primary battery as the energy supply system, nylon wire as the micro-channel material and polydimethylsiloxane (PDMS) as the packaging material. The size of the device is 20.2mm×39.7mm×3.7mm, while the effective size is 16.0mm×22.0mm×3.7mm. The battery is activated by a simple finger press right before being used. The working voltage is up to 1.95V, and it can provide a continuous power supply of 1.4V for 10h. The battery has the advantages of flexibility and easy fabrication.

……

FrC1.4 Passive and Wireless Strain Sensor for Torque Monitoring on a Rotating Shaft

Chia-Min Chao, National Chiao Tung Univ.
Che-Fu Liu, National Chiao Tung Univ.
Cheng Tu, National Chiao Tung Univ.
Yen-Ming Liao, National Chiao Tung Univ.
Wensyang Hsu, National Chiao Tung Univ.

Measuring the output torque of a rotary machine, such as an electric motor, is important in order to monitor the output performance of the machine. However, it usually needs to couple a torque meter between two rotating shafts, or modify the shaft with extra machining process to install the torque sensor. Here, we present a passive and wireless strain sensor based on inductive-capacitive (LC) circuit principle. The capacitive strain sensing pad is glued on the target shaft and connected to a sensing inductor. The strain variation on the shaft surface can be obtained through wireless measurement of the resonant frequency. The sensor pad does not need to connect to the battery, and only the external reader needs power source. Our preliminary results show that the proposed device can provide high strain resolution in the static torque measurement, and the dynamic output torques measurement of a servo motor at different speeds are successfully carried out. The proposed sensing device has great potential to monitor the output torque of a rotating shaft in real-time at low cost.

……

FrD1 Best Conference Paper Award Finalist

Session Chair: Jin-woo Kim
11:10 - 12:40, Friday, April 12 (Room: Thai Boromphimarn 4, 3/F)

FrD1.1 Investigating the Effects of Electron Beam Irradiation on Nanoscale Adhesion

Sören Zimmermann, Univ. of Oldenburg
Han Huang, The Univ. of Queensland

Electron microscopy allows for resolving of structure sizes far below the resolution limit of optical microscopes and is therefore increasingly applied as an in-situ imaging method during manipulation and characterization of nanomaterials. However, little is known about the influence of the electron beam used on the respective experiment, which can lead to considerable uncertainty about the repeatability of the relevant manipulation sequence or the accuracy of the characterization results obtained. Here we investigate the influence of electron beam irradiation on nanoscale adhesive interactions using piezoresistive force sensors decorated with individual colloidal particles. We can demonstrate that both electron beam-induced deposits as well as electrostatic forces can dominate the relevant adhesion mechanisms. The results thus clearly reveal the importance of considering effects originating from electron beam irradiation in the conduct and interpretation of in-situ experiments, which in turn is of significant relevance for the growing community of

researchers involved in this methodology.

……

FrD1.2 Microfluidic Systems for Fast and Accurate Diagnosis of Ovarian Cancers

Yi-Cheng Tsai, Dept. of Power Mech. Eng., National Tsing Hua Univ.
Wei-Ting Liu, Dept. of Power Mech. Eng., National Tsing Hua Univ., Taiwan
Sheng-Po Haung, Dept. of Power Mech. Eng., National Tsing Hua Univ., Taiwan
Wen-Bin Lee, Dept. of Power Mech. Eng., National Tsing Hua Univ., Taiwan
Yuan-Jhe Chuang, Dept. of Obstetrics and Gynecology, National Cheng Kung Univ. Hospital, College of Medicine, Taiwan
Keng-Fu Hsu, Dept. of Obstetrics and Gynecology, National Cheng Kung Univ. Hospital, College of Medicine, Taiwan
Gwo-Bin Lee, Dept. of Power Mech. Eng., Inst. of Biomedical Eng., and Inst. of NanoEng. and Microsystems, National Tsing Hua Univ., Hsinchu, Taiwan.

Precise and fast diagnosis of cancer is challenging. Aptamers have been regarded as promising artificial antibodies for cancer therapy and detection. However, in order to screen highly specific and high-affinity aptamers targeting specific cancer, it requires a series of complex procedures. Furthermore, the screened aptamers may require further optimization for drug delivery. Moreover, further clinical applications for cancer diagnosis such as immunohistochemistry (IHC) staining is a labor-intensive, time-consuming procedure which requires well-trained personnel for carrying out the tedious process. In this work, we reported our recent progress on utilizing integrated microfluidic systems to tackle the above issues. Customized flow and temperature control modules have been established to carry out a fast and automated continuous aptamer screening process on a microfluidic chip for screening ovarian cancer (OvCa) specific aptamers targeting plasma membranes of tissues. Another integrated microfluidic platform was also developed for performing the whole process of IHC staining including the sample pretreatment of tissue samples. With these approaches, aptamers could be used for recognizing and detecting clinical tissue samples for OvCa.

……

FrD1.3 Sweat Lactic Acid Monitoring System using Adhesive Plaster-based Sweat Sampling Device

Hiroyuki Kudo, Meiji Univ.
Yusuke Suzuki, Meiji Univ.
Yoshiki Tojo, Meiji Univ.
Haruna Saito, Meiji Univ.
Keigo Enomoto, Meiji Univ.

A microfluidic lactic acid (LA) monitoring system for sweat LA monitoring was fabricated and tested. Sweat is a promising candidate for non-invasive monitoring of chemical content in human body. However, there are several difficulty in sweat monitoring resulted from sweating mechanism. We employed a continuous flow of phosphate buffer saline at the surface of the skin as a career flow transporting whole secretions to a LA biosensor. The sampling device was improved using adhesive-plaster and this contributed to two major advantages in this method. The first is that it is possible to measure sweat LA continuously regardless the sweat rate. The second is the capability of continuous monitoring because the chemical condition at the surface of the skin can be always refreshed by the continuous flow. In the experiment, the sampling device was connected to the biosensor, which sensitivity to LA was 53.1 nA μM-1. The biosensor was operated using a wireless potentiostat and the continuous career flow was supplied by dual diaphragm pump system. As a real-sample test, the monitoring system was utilized to LA monitoring of jogging subject and swimming subject, respectively. In both cases, kinetics of sweat LA of free-moving subjects were successfully monitored.

……

FrD1.4 Stretchable Helical Wiring with Liquid Metal

Hiroki Ota, Yokohama National Univ.
Ken Matsubara, Yokohama National Univ.

In this study, stretchable liquid metal (Galinstan) wiring with three-dimensional(3D) coil was developed for preventing the resistance change during device deformation(Fig. 1). Previously, core-shell hydrogel micro-springs was fabricated using a double bevel-tip nozzle[1]. In this study, liquid metal as conductive liquid was injected into core part composed of starch in the microsprings. Then, we developed 3D coil with liquid metal. In stretchable and flexible electronics, it is crucial to prevent change of electrical parameters, in particular resistance in direct current(DC) and impedance in alternating current(AC), during device deformation. Our metal wiring maintained stable resistance (less than 1.2 % difference) during 100 % tension and stable impedance(less than 0.2%) from 1 to 100k Hz in AC. As a result, we realized liquid metal wiring which is highly stable to device deformation. This report will present an important advancement towards the realization of "liquid-state" electronic system with liquid meal.

……

FrD1.5 Isotropic Nanophotonic Modulation with Hybrid Configuration for Surface Plasmon Resonance Application

Yu-Tang Hu, National Tsing Hua Univ.
Kuo-Feng Chiu, National Tsing Hua Univ.
Ting-Jeng Liu, National Tsing Hua Univ.
Cheng-Yao Lo, National Tsign Hua Univ.

This paper reports a novel method to modulate the surface plasmon resonance (SPR) by isotropically straining a polymeric substrate to induce reconfigurations of photonic nanostructures above the substrate. By macroscopic straining the substrate, the microscopic stress was transferred to the metallic nanostructures, which in turn induced different SPRs, as the operating principle. Studies indicated that although the substrate was anisotropically strained in limited directions, the SPR was modulated isotropically at the geometric center of the elastomer. Demonstrative isotropic SPR modulation was achieved with a single and fundamental configuration of the nanostructures for the first time, and the tunable operation was proved by a color switching from blue to green. Comprehensive theoretical optical and mechanical designs, numerical optical and mechanical evaluations, device fabrication, experimental verification, and analysis were conducted in this work.

……

FrC2 Nanoelectronics and Circuit

Session Chair: Chih-Ting Lin
14:00 - 15:30, Friday, April 12 (Room: Thai Boromphimarn 3, 3/F)

FrC2.1 A Real-Time Free Chlorine Monitoring by Graphene Field-Effect Transistor (GFET)

Kunpot Mopoung, Chulalongkorn Univ.
Pattana Suwanyangyaun, Chulalongkorn Univ.
Reiji Odanaka, Aoyama Gakuin Univ.
Shohei Kosuga, Aoyama Gakuin Univ.
Takeshi Watanabe, Aoyama Gakuin Univ.
Shinji Koh, Aoyama Gakuin Univ.
Sakuntam Sanorpim, Chulalongkorn Univ.

Free chlorine by dissolving dissolving sodium hypochlorite (NaClO) is commonly used in water treatment process for drinking water. The important factor for water treatment is using the right concentration of

free chlorine. The standard method to check free chlorine concentration is using N-N-diethyl-p-phenylenediamine (DPD) which is required expensive instrument and not suitable for a real-time monitoring system. Thus, we have fabricated a real-time graphene field effect transistor (GFET) for monitoring free chlorine concentration. A monolayer graphene was grown by low-pressure chemical vapor deposition (LP-CVD) on Cu foil and then transferred to silicon substrate to be a sensing material of GFET. The source and drain electrodes of GFET were Au/Cr, while gate electrode was Ag/AgCl. Free chlorine concentrations (0 to 30 ppm) were diluted from NaClO in phosphate buffered saline (PBS). Our The current-voltage (I-V) characteristic measurements from GFET show results that relative responding of the current (ISD) in the range of 0 to 3 ppm of free chlorine concentrations. It is suitable for free chlorine monitoring especially in drinking water. GFET is promising to be the new standard for free chlorine concentration monitoring system.

……

FrC2.2 Delay approximation for nanomagnetic logic based combinatorial circuits

Neha Oraon, IIIT-Bangalore
Madhav Rao, International Inst. of Info. Tech.-Bangalore

Nanomagnetic logic (NML) based digital subsystem is considered effective for low power applications, where moderate performance is acceptable. The interplay between the neighboring magnetic dots due to the magnetostatic interactions offers stable domain orientations, which is viewed as logical outputs. NML is studied at device and at primitive gate level in the past, but the functionality is not modeled at circuit level. The CMOS circuits are well studied and a quick approximation tool estimating delay and energy is highly utilized in designing large digital subsystem. A similar quick approximation modeling tool to evaluate delay of a large NML circuits is presented in this paper. The modeled approximation delay was further verified with the simulation results of NML based 1, and 2 bit full adder circuits.

……

FrC2.3 Effects of Heating on the Performance of 70 nm Thick Domain Patterned Permalloy Incorporated RF Spiral Inductors

Vasu Pulijala, VNIT Nagpur
Azeemuddin Syed, International Inst. of Info. Tech. Hyderabad

This paper discusses the effects of heating on the performance of aluminum spiral inductors incorporated with 70 nm Permalloy domain patterns. Spiral inductors with domain patterned Permalloy are heated to temperatures 373 K, 473 K and 573 K respectively. After heating till each temperature the wafer is cooled down to measure inductance and series resistance of spiral inductors. It is observed that shape and size of the pattern influences the variation of permeability of Permalloy with heating.

……

FrC2.4 Optimization of the drive circuit for the sensitivity-enhanced film bulk acoustic resonator

Lidong Du, State Key Lab. of Transducer Tech., Aerospace Info. Res. Inst., CAS, China
Jihang Liu, Univ. of CAS, China
Yusi Zhu, Univ. of CAS, China
Zhan Zhao, State Key Lab. of Transducer Tech., Aerospace Info. Res. Inst., CAS, China
Zhen Fang, State Key Lab. of Transducer Tech., Aerospace Info. Res. Inst., CAS, China

An optimal drive circuit for the sensitivity-enhanced film bulk acoustic resonator (SE-FBAR) has been presented in this paper. The SE-FBAR is made of a thin ZnO piezoelectric film sandwiched by two electrodes. The drive circuit started with a kind of Parallel Feedback Pierce circuit (common-base Clapp driving circuit) in which the Modified Butterworth-Van Dyke (MBVD) equivalent circuit of FABR is used. By theoretically calculating, it is proved that there is a minimal capacitance that makes the load quality factor of FABR QL has the maximal value. After simulation in Advanced Design System (ADS), it is shown that the drive circuit worked at the resonant frequency 1.488GHz.

……

FrD2 Best Student Paper Award Finalist

Session Chair: Jin-woo Kim
14:00 - 15:30, Friday, April 12 (Room: Thai Boromphimarn 4, 3/F)

FrD2.1 Free-spaced-coupled Liquid Crystalline Broadband Optoacoustic Sensors

Michael Dela Cruz, The US Air Force Inst. of Tech.
Ling Wang, Texas A&M Univ.
Hengky Chandrahalim, The US Air Force Inst. of Tech.

This work presents the first possible realization of chip-scale liquid crystalline (LC) optoacoustic sensors that have the capability of detecting broadband acoustic signals via free-space coupling using white light input. The interaction between acoustic waves and the optical and mechanical properties of the LC molecular cavities was investigated. Systematic comparisons between a commercially available acoustic sensor system and the geometry-independent LC optoacoustic sensors are provided. This work will enable economical, compact, reliable, broadband, noncontact, and sensitive molecular-based acoustic sensors for use in various applications.

……

FrD2.2 Fabrication of a Wearable Temperature Sensing System for CIPA Patients

Brian D. Hanson, UMBC
Adam Der, UMBC
Morgan Freeman, UMBC
Christopher Slaughter, UMBC
Saikat Banerjee, UMBC
Gymama Slaughter, Univ. of Maryland Baltimore County

Rare diseases such as Congenital Insensitivity to Pain with Anhidrosis (CIPA) inhibit individuals from living independently such that they require special accommodations to perform daily activities. Based on the complications associated with the CIPA, we designed and fabricated an assistive technology device to inform individuals of the extreme temperature variation in their surrounding environment. The temperature sensing system utilizes a resistance temperature detector (RTD) incorporated in a glove apparatus that is capable of monitoring temperature variation while handling hot objects. The RTD is developed via microfabrication techniques, wherein chromium/nickel (Cr/Ni) metallization layers were photo-patterned on a glass substrate to serve as the sensing element. An Anderson loop circuit (ALC) is fabricated with surface mount devices to supply a constant current source for the RTD. This enables consistent resistance output signals to be obtained from the RTD. The wireless component consists of the ESP8266 Arduino microcontroller for measuring real-time voltage data from the RTD, which is transmitted to a smartphone via a web server. The RTD system exhibits a linear dynamic response in the temperature range of 26 °C and 50 °C with a correlation coefficient of 0.996.

……

FrD2.3 Enhance Raman chip via nano-shield mechanism to form Nano-pillar array Structure Applied to liquid biopsy detection on oligonucleotide.

Meng-Ju Pan, National Tsing Hua Univ.
Fan-Gang Tseng, National Tsing Hua Univ.

In this paper we propose a nano-shield mechanism via polystyrene beads (PSBs) to resist the chemical etching, simultaneously produce a highly selective etching ratio to create more hot-spots for Surface-enhanced Raman spectroscopy (SERS) enhancement of a Janus-Biosensor. In this paper reports an improved method for processing nona-pillar array structure characterized by High-Aspect-Ratio, which extend the third dimension of hot-spots distribution. After depositing gold, nano-pillar array produce more hot-spots for greater SERS enhancement around 10 times than original substrate, which sensor could be proposed as high sensitivity bio-sensing application purpose. With this SERS substrate, we can improve the sensitivity to distinguish clearly of the hybridization process by Raman spectrum in label-free way. With this method, we will have a widespread implication in DNA analysis. Especially detecting biomarkers in liquid biopsy field, to achieve the final purpose of early cancer screening. Keywords— High-Aspect-Ratio nano-structures; SERS; Janus-Biosensor; DNA detection; liquid biopsy.

……

FrD2.4 ENHANCED VISIBLE-RESPONSIVE PHOTODEGRADATION THROUGH SnFe2O4 NANOPARTICLES WITH MODIFIED MAGNETIC ARTIFICIAL CILIA ACTUATION

Bivas Panigrahi, Ph. D scholar
Chia-Yuan Chen, NCKU, Taiwan

In this work, we have demonstrated that with the combination of SnFe2O4 nanoparticles and modified magnetic artificial cilia actuation, a highly efficient photocatalytic activity can be achieved under the visible light. Three different modes of artificial cilia actuation were tested through micro-particle image velocimetry analysis and a relation has been established between photocatalytic efficiency and the corresponding vorticity contours generated due to artificial cilia beating. With the optimized artificial cilia rotation, a superior performance was achieved with a maximum degradation rate of 81.7% in 60 minutes using the presented design.

……

FrD2.5 Miniaturized Drug Delivery System for Biomedical Applications

Khalil Moussi, King Abdullah Univ. of Sci. and Tech.
Mohammed AlDajani, King Abdullah Univ. of Sci. and Tech.
Jurgen Kosel, King Abdullah Univ. of Sci. and Tech.

A miniaturized 3D printed drug delivery device powered wirelessly is presented. The device is composed of an electrochemical micropump, a 3D printed reservoir with microneedles, and a wireless powering unit. The electrochemical pump features an expandable (up to 300%) Parylene C micro-bellows membrane fabricated by mold casting, using a two-photon polymerization 3D printing technique. The hollow microneedles are 100 μm in diameter and 300 μm long. The fabrication process offers customizable device properties, where the shape, size, and performance can be tailored to fit a wide range of in vivo drug delivery applications. Delivery of 3.8 ± 0.3 μL within 10 seconds of actuation is demonstrated, using inductive wireless powering at a distance of 10 mm between the primary and secondary coils.

……

FrD2.6 Design and Experiment of an Ultra-Low Frequency Pendulum-Based Wave Energy Harvester

Yunfei Li, Soochow Univ.
QIyu Guo, Soochow Univ.
Huicong Liu, Soochow Univ.
Tao Chen, Soochow Univ.
Lining Sun, Soochow Univ.
Xin Ma, Ocean Univ. of China
Zhaohui Chen, Ocean Univ. of China

This paper reports an energy harvester based on pendulum to harvest energy from ultra-low frequency ocean waves. When the eccentric mass pendulum is subjected to an excitation wave, it generates a large angle of oscillation or even rotation. The kinetic energy collected by the device is transmitted to an electromagnetic power generation module through the gears. The motion behavior of the device under different wave amplitudes and frequencies are explored by using ADAMS software. The shape, size and material of the mass pendulum are optimized. In the simulation, the maximum open-circuit voltage of the device can reach to 15 V under the wave amplitude of 20 cm and frequency of 1 Hz. It has the maximum output power of 0.4 W with an external resistance of 100 Ω. When tested in a large experimental tank, the output of the device is also good. The maximum open-circuit voltage and power of the device can reach to 8 V and 0.16 W under the wave amplitude of 20 cm and period of 3 s. The volume of the device is 100 * 100 * 56 mm3.

……

FrPo1 Poster Session 1

Session Chair: Cecil Chen
Session Co-Chair:
15:30 - 16:30, Friday, April 12 (Room: Pre-function Area, 2/F)

FrPo1.1 An optically-induced-dielectrophoresis (ODEP)-based microfluidic system for high-purity isolation and purification CD45neg/EpCAMneg cells in the blood samples of cancer patients

Yu-Xian Zhu, Chang Gung Univ.
Tzu-Keng Chiu, Chang Gung Univ.
Chia-Jung Liao, Chang Gung Univ.
Wen-Pin Cho, Chang Gung Univ.
Min-Hsien Wu, Chang Gung Univ.

Cancer metastasis is a leading cause of cancer- derived death. With the recent studies on circulating tumor cells (CTCs) they hold immense potential to provide more valuable information on the mechanism of cancer metastasis. In current CTC studies, however, CTCs are normally defined as the cancer cells in blood circulation that express specific surface antigens- EpCAM(CD45neg/ EpCAMpos). The studies based on this could miss the other metastatically more meaningful cancer cells due to high heterogeneity of CTCs (CD45neg/ EpCAMneg). To address these issues, we aim to develop an optically-induced dielectrophoretic force-based microfluidic biochip system for high purity cell isolation. We will use it to isolate target cells in a blood sample that includes leukocytes (CD45pos), conventionally defined CTCs (CD45neg/ EpCAMpos), and an unknown cell group (CD45neg/ EpCAMneg) in this study. In the future works, the technique of real-time PCR will be utilized to analyze the expression of cancer-related genes of the cell species abovementioned. Through these investigations, we will examine if there are "atypical CTCs".

……

FrPo1.2 Patterning of Intricate In-Channel Features by Sacrificial Molding of 3D Printed Mold

JASON WEI HUANG GOH, SINGAPORE Univ. OF Tech. AND DESIGN
Michinao Hashimoto, SINGAPORE Univ. OF Tech. AND DESIGN

Fabricating 3D microchannels with in-channel features by replica molding has been challenging due to the multiple steps required to align

and assemble components. We present a technique by sacrificial molding to fabricate a microchannel with 3D intricate patterns within the microchannel. The sacrificial mold made of polyvinyl alcohol (PVA) was printed using a fused deposition modeling (FDM) 3D printer. As a demonstration, we fabricated a microchannel with staggered herringbone patterns imparted on both the bottom and top surfaces. Sacrificial molding allowed fabricating the entire microfluidic mixer without the need for alignment, stacking of sealing of different components of the assembly. The capability to mix laminar flows was drastically enhanced in the microchannel patterned on staggered herringbone patterns on the top and bottom surfaces compared to a typical microchannel devoid of any in-channel features. To this end, we believe that sacrificial molding coupled with additive manufacturing provides a facile route to fabricate microchannels with complex morphologies within the channel.

……

FrPo1.3 Development of a 4H-SiC Piezoresistive Pressure Sensor for High Temperature Applications

Xudong Fang, State Key Lab. of Robotics and System (HIT),State Key Lab. for Manufacturing Systems Eng., Int. Joint Lab. for Micro/Nano Manufacturing and Measurement Technologies, Xi'an Jiaotong Univ., China
Chen Wu, State Key Lab. for Manufacturing Systems Eng., Int. Joint Lab. for Micro/Nano Manufacturing and Measurement Technologies, Xi'an Jiaotong Univ. , China
Xin Guo, State Key Lab. for Manufacturing Systems Eng., Int. Joint Lab. for Micro/Nano Manufacturing and Measurement Technologies, Xi'an Jiaotong Univ., China
Libo Zhao, State Key Lab. for Manufacturing Systems Eng., Int. Joint Lab. for Micro/Nano Manufacturing and Measurement Technologies, Xi'an Jiaotong Univ., China
Yulong Zhao, State Key Lab. for Manufacturing Systems Eng., Int. Joint Lab. for Micro/Nano Manufacturing and Measurement Technologies, Xi'an Jiaotong Univ., China
Zhuangde Jiang, State Key Lab. for Manufacturing Systems Eng., Int. Joint Lab. for Micro/Nano Manufacturing and Measurement Technologies, Xi'an Jiaotong Univ., China

A piezoresistive pressure sensor based on 4H-SiC was developed for working over 500°C. The designed pressure range is 0-7MPa for special aviation applications. As demonstrated with experimental results, in this pressure range, the sensor shows excellent accuracy and repeatability from 30°C to 500°C. Compared with previous studies, in MEMS processing of the sensor chip, a suitable alloy system was determined to form a stable high-temperature ohmic contact. Besides, the chip was packaged with mechanical structure and ceramic glue of similar thermal expansion coefficient to avoid thermal stress induced when increasing temperature. With the above measures taken, the sensor performance can be significantly improved. The design, fabrication, and package of this sensor provide support for high-temperature use. Additionally, this work can be a reference for future research in this field.

……

FrPo1.4 Fabrication and numerical analysis of three-dimensional electrodeless dielectrophoresis chip

Yang-Yu Chang, National Formosa Univ.
junan kuo, National Formosa Univ.
Chun-Da Chen, National Taiwan Univ. Hospital Yunlin Branch

In this study, a three-dimensional electrodeless dielectrophoresis (EDEP) microfluidic chip is proposed and numerical analysis systematically. The channel is 600 nm deep and 500 μm width with a 5 μm constriction gap patterned on a borosilicate glass coverslip (thickness of 160 μm) by BOE wet etching. The glass substrate was bonded to a PDMS microchannel with two via holes with an oxygen plasma treatment to complete the EDEP chip. Numerical simulations were facilitated to investigate the phenomena of electrokinetics, i.e., dielectrophoresis and electroosmosis. The purpose of the device is utilizing MEMS technology to fabricate a 3D microchannel-based EDEP chip enhances the local electric field intensity (10^7 V/m) and can generate positive and negative dielectrophoretic force at an insulating microconstriction structure for separate and concentrate nanoparticles. Overall, the proposed EDEP device provides a high local electric field intensity, a low-cost solution and overcomes the Poisson statistical limit owing to 3D structure with a large capacity of a mL-scale sample volume.

……

FrPo1.5 Effect of Oxidation on Conductivity Characteristics of Tungsten-Rhenium Thin-Film Thermocouples Sensor

Zhongkai Zhang, Xi'an Jiaotong Universtity
Bian Tian, Xi'an Jiaotong Universtity
Zhe Du, Xi'an Jiaotong Universtity
Qijing Lin, Xi'an Jiaotong Universtity
Kaikai Li, Xi'an Jiaotong Universtity
Na Zhao, Xi'an Jiaotong Universtity
Zhuangde Jiang, Xi'an Jiaotong Universtity

This paper reports a temperature sensor based on tungsten-rhenium thin-film thermocouples (TFTCs) to test temperature. Changes in the oxidation process on conductivity of TFTCs have been discussed to optimize the sensor. It will allow the low interference measurement of temperature field under a harsh working environment.

……

FrPo1.6 Calibration of MEMS Based Inertial Measurement Unit Using Long Short-Term Memory Network

Jinkui Wang, Beijing Inst. of Tech.
Wenzhong Lou, Beijing Inst. of Tech.
Peng Liu, Beijing Inst. of Tech.
Weitong Liu, Beijing Inst. of Tech.

This paper adopts the end-to-end approach to correct the inertial measurement unit, In this paper, the Recurrent Neural Network (RNN) is used to correct the inertial measurement unit error. The inertial measurement unit integrated by three accelerome-ters and three gyroscopes is shown in Fig 1. The IMU is placed at the center of the three-axis turntable, and the turntable rotates at a certain rate, as shown in Fig 2, recording the angular rate, attitude of the turntable and output signal of IMU simultaneously. Recurrent neural network is shown in Fig 3, which contains an LSTM network, a linear layer and two output layers; training results using simulated data of gyroscope are shown in Fig 4, noise is filtered out success. Parameters are written into the IMU, and the test results on the three-axis turntable are shown in Fig. 5, proved the effectiveness of our algorithm.

……

FrPo1.7 Design and Testing of MEMS Metal Bridge Solid State Switch

Hengzhen Feng, Beijing Inst. of Tech.
Wenzhong Lou, Beijing Inst. of Tech.
Xuran Ding, Beijing Inst. of Tech.
Fuquan Zheng, Beijing Inst. of Tech.
Maohao Liao, Beijing Inst. of Tech.

Traditional micro-mechanical switch processing requires high precision, but there is a problem of poor consistency of the processing technology. In this paper, a MEMS metal bridge solidstate switch with small size, good consistency, safety and controllability is developed. The MEMS micro-actuator designed in this paper a planar structure. There is a metal bridge structure in the device. Due to the characteristics of the metal bridge structure, the high current pulse drive signal tends to generate a large amount of Joule heat at the bridge structure of the device. In order to understand the possible failure conditions of the device, this paper

analyzes the effect of such Joule heat inside the device, carries out related theoretical calculations, and uses COMSOL to complete the failure simulation analysis of multiphysics coupling. At the same time, this paper has carried out reliability research on chip manufacturing, packaging and soldering process through wafer level test and device level test, and optimized the structure design. Finally, the processing and packaging of the device MEMS metal bridge solid state switch is realized.

……

FrPo1.8 Low-energy Nanoelectromechanical Switches by Controllable and Reversible Nanocrack

qiang luo, School of Optical and Electronic Info., Huazhong Univ. of Sci. and Tech., China
zhe guo, School of Optical and Electronic Info., Huazhong Univ. of Sci. and Tech., China
shuai zhang, School of Optical and Electronic Info., Huazhong Univ. of Sci. and Tech., China
xiangwei jiang, State Key Lab. for Superlattices and Microstructures, Inst. of Semiconductors, CAS, China
hongjuan wang, State Key Lab. for Superlattices and Microstructures, Inst. of Semiconductors, CAS, China, China School of Microelectronics, Xidian Univ., China
genquan han, School of Microelectronics, Xidian Univ., China
jeongmin hong, School of Optical and Electronic Info., Huazhong Univ. of Sci. and Tech., Wuhan 430074, China
long you, School of Optical and Electronic Info., Huazhong Univ. of Sci. and Tech., China Wuhan National Lab for Optoelectronics, Huazhong Univ. of Sci. and Tech., China

This paper reports a novel nanoelectromechanical (NEM) switch through exploiting electrically controllable and reversible single nanocrack in an alloy film/ferroelectric oxide heterostructure. The crack can be formed in a controlled way in terms of its initiation, position, and orientation through using a bridge-like structure. The crack state (open/closed) can be programmed under a cyclic electric field and is nonvolatile. In addition, due to its mechanical switching behavior, a high ON/OFF current ratio (>107) and near-zero static power consumption can be achieved. This simple NEM switch concept presents new opportunities for new nonvolatile random-access memory and configurable logic tables.

……

FrPo1.9 Fluorescent Immunosensing Enhanced with a Bead-based Optoelectrokinetic Platform

Han-Sheng Chuang, National Cheng Kung Univ.
Hsiao-Neng Lin, National Cheng Kung Univ.
Jen-Yi Wang, National Cheng Kung Univ.

Bead-based immunosensing is a promising technology in the point-of-care diagnostics due to its high flexibility. For dilute samples, functionalized particles can concentrate dispersed analytes and act as carriers for particle manipulation. To realize rapid and selective diagnosis, a bead-based optoelectrokinetic immunosensing technique, termed rapid electrokinetic patterning (REP), was employed herein to detect a biomarker, lipocalin 1 (LCN1), for diabetic retinopathy (DR). The measurement was made in an aqueous droplet sandwiched between two parallel electrodes. With an electric field and a focused laser beam applying on the microchip simultaneously, the immunocomplexes in the droplet were further concentrated to enhance the fluorescent signal. The detection required only several tens of seconds. The limit of detection (LOD) reached nearly 100 pg/mL. The combined use of bead-based immunoassays and the optoelectrokinetic platform enables a noninvasive measure to the early diagnosis of DR.

……

FrPo1.10 Optical Fiber MEMS Micro Pressure Sensor Based On Beam-membrane Structure

Bian Tian, Xi'an Jiaotong Univ.
Kaikai Li, Xi'an Jiaotong Univ.
Zhongkai Zhang, Xi'an Jiaotong Univ.
Feng Han, Xi'an Jiaotong Univ.
Na Zhao, Xi'an Jiaotong Univ.
Qijing Lin, Xi'an Jiaotong Univ.
Zhuangde Jiang, Xi'an Jiaotong Univ.

In this paper, an optical fiber MEMS (Micro-Electro-Mechanical System) micro pressure sensor based on BM (beam-membrane) structure is proposed. The most important part of the sensor is composed of a sensitive silicon diaphragm and a dual fiber collimator. In the designed optic fiber micro pressure sensor, the sensitive silicon diaphragm creatively utilizes a BM structure made by MEMS manufacturing technology. By comparing other structures and performing simulations, the BM structure has better linearity while ensuring its sensitivity is concluded. The BM structure is used to reflect light, and the dual-fiber collimator is used to transmit and receive light. The measurement range of the sensor is from 0KPa to 10KPa. The intensity demodulation makes the whole system easier to realize and ensures the performance of the sensor. By setting up the sensor experimental platform and conducting experiments, the sensitivity of the designed sensor is -0.252db/KPa.

……

FrPo1.11 Study on three dimensional additive manufacturing process using X-ray radiolysis

Akinobu Yamaguchi, Univ. of Hyogo
Ikuya Sakurai, Nagoya Univ.
Ikuo Okada, Nagoya Univ.
Atsushi Yamaguchi, Hyogo Prefectural Inst. of Tech.
Mari Ishihara, Hyogo Prefectural Inst. of Tech.
Takao Fukuoka, Univ. of Hyogo
Satoru Suzuki, Univ. of Hyogo
Yuichi Utsumi, Univ. of Hyogo

We present the synthesis of nano/micro-scale metallic and oxidized particles onto various substrates using the X-ray radiolysis with a manufactured flow system. As a typical example, the cupric particles are deposited onto the substrates. Scanning electron microscopy with energy dispersive X-ray analysis, X-ray diffraction, micro-Raman spectroscopy have been demonstrated to investigate and understand the physical and chemical mechanisms to synthesize the particles. These analyses enable us to provide the understanding that the radical ions nucleated by the X-ray irradiation in the solution play a significant role in synthesizing and ripening of particles and clusters. The process using X-ray radiolysis sheds light on the novel three dimensional additive manufacturing process for three dimensional structure formation and additive process.

……

FrPo1.12 Development of Retina Cell-laden Alginate Microbeads for Study of Glaucoma

Hongyong Zhang, South Univ. of Sci. and Tech. of China
Zeyang Liu, Stem Cell Therapy and Regenerative Medicine Lab, Tsinghua-Berkeley Shenzhen Inst. (TBSI), Shenzhen, China.
Chengzhi Hu, Dept. of Mech. and Energy Eng., Southern Univ. of Sci. and Tech., China.
HAOCHEN NAN, South Univ. of Sci. and Tech. of China

Raised intraocular pressure is the main cause of primary open angle glaucoma. Exerting controlled force on in vitro grown retinal cells suggests a feasible and efficient approach for quantitatively study of the relationship between the intraocular pressure and glaucoma. Biological experiments have demonstrated that retina cells can proliferate in hydrogel microbeads. In this paper, alginate hydrogel microbeads are

fabricated for in vitro cultivation of retinal cells. A simple flow-focusing microfluidic device made with syringe needles and silicone tube was designed to fabricate alginate microbeads. These microbeads are fabricated by forming water in oil droplet in silicone tube, then these alginate droplets are crosslinked by calcium solution. By tuning the flow rate of oil and alginate solution, the size of hydrogel microbeads can be controlled. The oil coated on the alginate hydrogel beads are removed by repeated washing in HEPES buffer solution.

……

FrPo1.13 The Test Structure to Measure Polysilicon Seebeck Coefficient for Thermoelectric-Photoelectric Integrated Generator

sen zhang, Southeast Univ.
Xiaoping Liao, Key Lab. of MEMS of the Ministry of Education, Southeast Univ.

We propose a polysilicon Seebeck coefficient test structure for a thermoelectric micro-generator for a wireless sensor nodes (WSNs). The polysilicon Seebeck coefficient test structure consists of an etched polysilicon, a polyimide layer, and a special structure interconnected by metal. The temperature measuring resistor is designed as a folded structure, which can increase the resistance value for testing. At the same time, four measuring electrodes are designed for each temperature measuring resistor, and the four-probe method can be used to accurately measure the resistance with less error. Since the Seebeck coefficient of the semiconductor material is much larger than that of the metal, the Seebeck coefficient of the polysilicon material is approximately equal to the Seebeck coefficient of the polysilicon/metal thermocouple. The test structure is extremely important for guiding the design of integrated generators.

……

FrPo1.14 A Novel Design of A Decoupled T-shape structure for Aluminum Nitride Gyroscope

Jian Yang, Inst. of Semiconductors, CAS, China; College of Materials Sci. and Opto-Electronic Tech., Univ. of CAS, China
Chaowei Si, Inst. of Semiconductors, CAS, China
Guowei Han, Inst. of Semiconductors, CAS, China
Jin Ning, Inst. of Semiconductors, CAS, China
Fuhua Yang, Inst. of Semiconductors, CAS, China
Xiaodong Wang, Inst. of Semiconductors, CAS, China; School of microelectronics, Univ. of CAS, China

This paper reports a decoupled design for piezoelectric aluminum nitride (AlN) gyroscope. A T-shape beam is proposed as a core structure. The coupling deformation, which comes from the drive mode, will polarize equal numbers of positive charge and negative charge on the sense electrode simultaneously. These coupling-induced charges will neutralize each other and no electrical signal outputs. Therefore, although there is a mechanical coupling between the drive mode structure and sense electrode, the charge neutralization can realize the decoupling between the drive mode signal and sense mode signal. In this work, the AlN gyroscope is designed and simulated by COMSOL Multiphysics 5.2a. The electrical properties were tested by the dynamic signal analyzer. The drive mode frequency is 25.11 kHz, and the sense mode frequency is 28.07 kHz. The two modes are decoupled perfectly according to the test results.

……

FrPo1.15 Statistically-designed Liquid Crystalline Molecular Cell Sensors

Michael Dela Cruz, The US Air Force Inst. of Tech.
Ling Wang, Texas A&M Univ.
Hengky Chandrahalim, The US Air Force Inst. of Tech.

This paper presents a statistical analysis of factors that influence the optical transmission characteristics of the Cholesteric Liquid Crystal (CLC) molecular cell. Two factors, percent dopant concentration and liquid crystal loading temperature, were chosen to design the optical bandgap slope of CLC as a preliminary demonstration for this method. Identification of dominant and ideal factor levels, including their interactions, enable a statistically enhanced molecular design method of CLC for broad sensor applications.

……

FrPo1.16 Fabrication and Evaluation of MEMS Piezoelectric Vibration Sensor with Energy Harvesting Function

Lan Zhang, National Inst. of Adv. Industrial Sci. and Tech.
Ryohei Takei, National Inst. of Adv. Industrial Sci. and Tech.
Jian Lu, National Inst. of Adv. Industrial Sci. and Tech.
Daiji Noda, Micromachine Center
Ryo Ohta, Micromachine Center
Toshihiro Itoh, The Univ. of Tokyo
Takeshi Kobayashi, National Inst. of Adv. Industrial Sci. and Tech.

We are going to introduce a MEMS piezoelectric vibration sensor with energy harvesting function. By 8-inch MEMS fabrication line, the piezoelectric sensors were fabricated successfully. The mechanical and electrical performance of the given sensors with different design were measured comprehensively. Endurance test of temperature circles was finished and the results demonstrated that the sensor can keep a stable output for reasonable performance after severe test. Finally, case studies of given sensor are implemented for considering the potential applications.

……

FrPo1.17 A HIGH ACCURACY RESONANT PRESSURE SENSOR WITH LATERAL DRIVEN AND PIEZORESISTIVE DETECTION

Xiangguang Han, Xi'an Jiaotong Univ.
Libo Zhao, Xi'an Jiaotong Univ.
Xuejiao Li, Xi'an Jiaotong Univ.
Ping Yang, Xi'an Jiaotong Univ.
Hongyan Wang, Shaanxi Inst. of Metrology Sci.
Zhuangde Jiang, Xi'an Jiaotong Univ.

A novel structure of resonant pressure sensor is presented with the electrostatic drive and piezoresistive detection. This design realizes double symmetric "H" beam assembled in one pressure diaphragm and symmetric-lateral vibration. When pressure applied, the Z-direction offset between driving and movable combs is less than 0.2 um with integrated comb design, which is beneficial for close-loop control. A novel structure combined with piezoresistive detection and coupling beam is presented, which can obtain pure tensile stress or compressive stress on the detection beam with low noise, adjacent modal output will be easy to filter. The simulated non-linearity of sensor after polynomial fitting is less than 0.01% within pressure range of 0-300 kPa, and sensitivity is up to -25 Hz/kPa.

……

FrPo1.18 A novel resonator based on in-plane mode for fluid density and viscosity measurements

Linya Huang, Xi'an Jiaotong Univ.
Libo Zhao, Xi'an Jiaotong Univ.
Dejiang Lu, Xi'an Jiaotong Univ.
Zhikang Li, Xi'an Jiaotong Univ.
Yulong Zhao, Xi'an Jiaotong Univ.
Zhuangde Jiang, Xi'an Jiaotong Univ.

A novel micro-electromechanical resonator based on in-plane mode was presented for the measurements of fluid density and viscosity. With the

purpose of enhancing the quality factor of micro resonator, double vibrators were connected by a center beam to not only drive the resonant structure in in-plane vibration mode but also reduce the vibration stress to be concentrated in the fixed terminal. Finite element analysis and numerical simulation were conducted to analyze and optimize the resonator structure. Based on the simulated analysis, its quality factor reached highly to 96 in ethanol with the resonant frequency of approximately 34 kHz. And the stress amplitude up to MPa on the center beam had strong relationship with both of the fluid characteristics and output voltage, which benefited to improve the measurement accuracy of fluid density and viscosity based on the piezoresistive principle.

……

FrPo1.19 A High-g Triaxial Piezoresistive Accelerometer with Sensing Beams in Pure Axial Deformation

Mingzhi Yu, Xi'an Jiaotong Univ., 710049, China
Libo Zhao, Xi'an Jiaotong Univ., Xi'an 710049, China
Chen Jia, Xi'an Jiaotong Univ., Xi'an 710049, China
Hongyan Wang, Shaanxi Inst. of Metrology Sci.
Yulong Zhao, Xi'an Jiaotong Univ., Xi'an 710049, China
Zhuangde Jiang, Xi'an Jiaotong Univ., Xi'an 710049, China

We present a new structure of a three-axis high-g accelerometer with pure axial deformation sensitive beams, which greatly improves the performance of the sensor. The sensor's measurement range is 100,000 g. The biggest advantages of the structure: First, the separation of the sensor support structure and the sensitive structure greatly weakens the direct coupling relationship between the natural frequency and sensitivity; Second, because of the special structural design, the sensitive beam of the sensor is always in a purely axially deformed state, to maximum use the deformation energy of the sensor, that greatly improves the sensitivity of the sensor. Then we simulated the main performance of the sensor and optimized the size parameters of the structure. And the processing process was designed. Finally, the sensor's simulation sensitivity is 1.2 μV/g/3V, and the simulation resonant frequency is 1.1MHz.Compared with the sensor performance of existing literatures, the accelerometer has excellent performance.

……

FrPo1.20 A Through-Hole Capacitive Micromachined Ultrasonic Transdcuer with High Perfromance

Jie Li, Xi'an Jiaotong Univ.
Libo Zhao, Xi'an Jiaotong Univ.
Dejiang Lu, Xi'an Jiaotong Univ.
Zhikang Li, Xi'an Jiaotong Univ.
Yihe Zhao, Xi'an Jiaotong Univ.
Tingzhong Xu, Xi'an Jiaotong Univ.
Shuaishuai Guo, Xi'an Jiaotong Univ.
Jiuhong Wang, Xi'an Jiaotong Univ.
Yulong Zhao, Xi'an Jiaotong Univ.
Zhuangde Jiang, Xi'an Jiaotong Univ.

Generally, CMUTs are composed of numbers of independent cells, whose edge are clamped on the post. Such structure is characterized by high resonant frequency and high sensitivity. However, too much parasitic capacitance is often introduced into the CMUTs because of the post between cells, causing a low electromechanical coupling coefficient. At the same time, the collapse voltage is too high and does not have low power consumption characteristics. In this paper, a Through-Hole CMUT structure (short for TH-CMUTs) is proposed, which is clamped at the four corners of the membrane. Since the stiffness of the structure is reduced, the TH-CMUTs has a low the collapse voltage. At the same time, the original membrane on the post is suspended, reslulting in the original parasitic capacitance transformed into the effective capacitance, which increases the electromechanical coupling coefficient. Finally, the structure also has the characteristics of high filling ratio and high transmitting power. All the advantage of this structure are simulated and validated.

……

FrPo1.21 Mathematical Model of Microfluidic Devices Employing Dielectrophoresis for 3D-Focusing

Salini Ramesh, UAE Univ.
Fadi Alnaimat, UAE Univ.
Ali Hilal-Alnaqbi, Abu Dhabi Polytechnique
Saud Khashan, Jordan Univ. of Sci. and Tech.
Anas Alazzam, Khalifa Univ.
Bobby Mathew, bmathew

The mathematical model of a dielectrophoresis based microfluidic device for 3D-focusing of micro-scale entities is presented in the article. The electrode configuration consists of multiple finite sized planar electrodes located on both sides of the top and bottom surfaces of the microchannel. The model accounts for forces associated with inertia, buoyancy, gravity, and dielectrophoresis. According to the model, the proposed electrode configuration can achieve 3D-focusing. In addition, the model demonstrates that the radius of micro-scale entity, volumetric flow rate, and initial locations do not have any influence on the focusing. However, focusing is influenced by the applied electric voltage. The fact that the micro-scale entity size and initial locations as well as volumetric flowrate do not influence focusing is a merit of the proposed microfluidic device.

……

FrPo1.22 Development of Gas Meter based on MEMS Thermal Flow Sensor

Ying Wu, chongqing Univ. of Sci. and Tech.
chengguang wu, chongqing Univ. of Sci. and Tech.

gas metering plays an important role in industrial and custom area. The existing gas meters are mainly developed on the basis of diaphragm flow measurement principle, which has the disadvantages that the starting flow rate is high, metering cannot indicate the calorific value directly, and measurement is susceptible to temperature and pressure. Therefore, many previous studies have demonstrated the successful application of MEMS thermal flow measurement with low starting flow rate and wide range ratio, which show the potential application on the field of thermal mass metering. This paper introduces a gas meter based on MEMS (Micro Electro Mechanical Systems) thermal flow measurement. The structure and working principle of the gas meter are presented. The thermal flow sensor is used to measure the mass flow. The integration of thermal sensor and gas channel has been finished. The performance of the gas meter is measured on sonic nozzle test platform. The experimental results show that the relative measurement error is less that 1.5% .

……

FrPo1.23 Flexible Pressure Sensor Array with Tunable Measurement Range and High Sensitivity

Dandan HUI, Tsinghua Univ., Shenzhen
Min Zhang, Tsinghua Univ., Shenzhen

Flexible tactile sensors are considered an effective way to achieve touch. Currently, conventional flexible tactile sensors have detection capabilities which are limited by sensitivity and range, and as simulated skin, the sensor needs to be relatively thin and fit snugly on the skin or robot arm. Therefore, the shape variables of the material are limited, and in order to have a good pressure distribution, a flexible pressure sensing array needs to be designed. In this paper, a high sensitive flexible pressure sensing array with tunable measurement range was demonstrated. Polyaniline and carbon nanotube coated polypropylene (PP) foam hybrid material was synthesized and used as the sensing material. The measurement range of the sensors can be tuned by polyvinyl alcohol (PVA) coatings

inside the pours of the PP foam without deteriorating sensitivity. The durability of PVA-coated sensors was verified by a 2000-time fatigue test.

……

FrPo1.24 Low Vacuum Sputtered Nanoporous Ag Films for Surface-Enhanced Raman Scattering

Sung-Ho Yun, Kyungpook National Univ.
Dongin Lee, Yeungnam Univ.
Bonghwan Kim, Daegu Catholic Univ.
Chanseob Cho, Kyungpook National Univ.

The purpose of this study was to devise a sputtering system for depositing nanoporous metal thin films at room temperature by using a cluster source in a conventional sputter system and to analyze the Raman response characteristics of the thin film as the process conditions were varied. The surface and cross sections of the deposited films were uniform and the porosity was between 78.8% and 79.7% when the thickness of the films was changed from 0.32 to 2.66 μm. The Raman intensity was 1 × 10^4 cps when the thickness of the thin film was 0.32 μm and increased as the thickness of the thin film increased. The Raman intensity reached a saturated value of 4.3 × 10^4 cps when the film thickness was about 2 μm. The Raman intensity and porosity increased with increasing process pressure, and EF increased from 3.21 × 10^6 at 50 mTorr to 5.7 × 10^6 at 350 mTorr. The fabricated metal nanostructures are applicable for sensors, catalyst, and SERS substrate for biosensors.

……

FrA3 Digital Microfluidics

Session Chair: Han-Sheng Chuang
Session Co-Chair: Cunjing Lv
16:30 - 18:00, Friday, April 12 (Room: Thai Chakkraphat 1, 2/F)

FrA3.1 Nanoparticles Synthesis using Digital microfluidics

Alsaeed Abualsayed, Mech. Eng. Dept., Assiut Univ.
Sara Abouelmagd, Dept. of Pharmaceutics, Assiut Univ.
Mohamed Abdelgawad, American Univ. of Sharjah

We developed a Digital Microfluidics platform for synthesis of Poly(Lactic-co-glycolic) acid (PLGA) Nanoparticles (NPs). As far as we know, it is the first time droplet manipulation on open surfaces is used in NP synthesis. The platform we developed is automated and allows for synthesis of polymeric NPs with smaller size and higher uniformity. Using our platform, we were able to prepare monodisperse PLGA NPs as small as 115 nm with a polydispersity index (PDI) of 0.14 which can be challenging with conventional preparation techniques on the macroscale. Size of the prepared NPs was found to decrease with increasing the volume ratio between the water droplet and the dimethylformamide-PLGA droplet merged on the device. Increasing the concentration of PLGA resulted in larger particle size and smaller PDI. We believe our results prove the potential use of digital microfluidics for testing combinatorial synthesis of different polymeric NPs for various applications.

……

FrA3.2 Effect of Waveform of the Actuation Signal on Droplet Speed in Digital Microfluidic Devices

Alsaeed Abualsayed, Mech. Eng. Dept., Assiut Univ.
Mohamed Abdelgawad, American Univ. of Sharjah

Many portable platforms were reported recently to provide low-cost and portable digital microfluidics (DMF) devices. Despite being able to generate the high voltages required for droplet actuation, the electronic circuits of these platforms generate distorted signals that are far from the regular AC sine wave form normally generated from convention setups (a function generator coupled to an amplifier). Here, we studied the effect of different wave forms (sine, square, and saw tooth) of the actuation signal on droplet speed on DMF devices. We also tested our own low-cost and portable droplet actuation setup and compared its actuation signal wave form with other forms. We found that droplet speed significantly depended on the wave form tested with the sine wave form achieving highest droplet speed. Our results indicate that a high actuation voltage should not be the single parameter to judge performance of electronic circuits for droplet actuation, and that the wave form produced is of equal significance.

……

FrA3.3 Modeling and Analysis of Micro-bubble Stiffness Measured by Atomic Force Microscopy

Huiyang Yu, City Univ. of Hong Kong
Zhiyong Sun, IMSE, HKU

In the past 50-60 years, the bubble has gained attention for its wide range of applications, especially in micro-scale. Research on the bubble's mechanical properties is necessary so that we can manipulate the bubble better (for better implementation). Precise measurement of the microbubble's mechanical properties (e.g., stiffness and surface tension) relies largely on delicate manipulation technology, as a result, atomic force microscopy (AFM) has been widely implemented. However, in previous AFM-scanned figures, microbubbles were usually captured with a relatively large distortion and the bubble topology was not clear enough to locate precisely the AFM probe so that further nanomanipulation or measurements could not occur. In this paper, AFM-based properties measurement of a single micro-bubble has been studied. An electrochemistry method was applied to generate stable bubbles. By using force volume mode, a single bubble was captured. The bubble, which should be isotropic, showed instead location-dependent anisotropic characteristics. In this case, the shape of the bubble (which influences the angle between the bubble's surface and the AFM tip) was proposed as the key reason to explain the anisotropic phenomenon, and a corresponding model was established to verify the hypothesis.

……

FrB3 Nanomaterials 1

Session Chair: Aditya Abburi
Session Co-Chair: Niti Yongvanich
16:30 - 18:00, Friday, April 12 (Room: Thai Chakkraphat 2, 2/F)

FrB3.1 Comparative Study of Gold Reduction Methods for Functionalizing Chemical Vapor Deposited Graphene

Li Lynn Shiau, Nanyang Technological Univ.
Beng Kang Tay, Nanyang Technological Univ.

This article reports on the hybridization of chemical vapor deposited graphene with Au nanoparticles. Au were reduced directly onto graphene surface by spontaneous reduction, NaBH4 and UV photo treatment. It was observed that spontaneous reduction and NaBH4 reduction methods produced Au particles of roughly 10 nm in diameter while UV treatment resulted in Au size of more than 100 nm. In all cases, Au 3+ were found to be fully reduced to Au0. In this report, four distinct reduction methods were compared for the fabrication of different Au NPs diameter on graphene. These methods include, spontaneous reduction via charge transfer, NaBH4 and UV photo reduction with or without spin coating of Au solution.

……

FrB3.2 Hierarchical Assembly of α-Fe2O3 Nanorods on SnO2 Nanosheet Arrays for Acetone Detection at Sub-ppm Level

Huimin Gong, Southern Univ. of Sci. and Tech.
Changhui Zhao, Southern Univ. of Sci. and Tech.
Wei Zhang, Southern Univ. of Sci. and Tech.
Gaoqiang Niu, Southern Univ. of Sci. and Tech.
Fei Wang, Southern Univ. of Sci. and Tech.

We report for the first time an acetone sensor based on novel SnO2/α-Fe2O3 hybrid nanoarrays (HNAs), which may be used in breath acetone analysis. The SnO2/α-Fe2O3 HNAs are synthesized through a cost-effective two-step liquid-phase process at low temperature. By applying an on-chip synthesis method, α-Fe2O3 nanorods are grown on the prefabricated SnO2 nanosheet arrays (NSAs). Gas-sensing properties of the SnO2/α-Fe2O3 HNAs based sensor are investigated, which shows a greatly improved response to acetone (2.3, at 0.4 ppm) at sub-ppm level compared to pure SnO2 NSAs (1.2, at 0.4 ppm). The SnO2/α-Fe2O3 HNAs based sensor also presents good selectivity and reproducibility to acetone, indicating its potential in practical application.

……

FrB3.3 A Nanodisk Array Based Localized Surface Plasmon Resonance (LSPR) Sensor Fabricated by Laser Interference Lithography

Chi-Chen Lin, Graduate Inst. of Biomedical Electronics and Bioinformatics, NTU
Jhih-Siang Chen, Graduate Inst. of Biomedical Electronics and Bioinformatics, NTU
Chien-Lin Wu, Graduate Inst. of Photonics and Optoelectronics, NTU
Lon A. Wang, Dept. of Electrical Eng., NTU
Nien-Tsu Huang, Dept. of Electrical Eng., NTU

In this paper, we combined laser interference lithography (LIL) and lift-off process to fabricate a periodic isolated gold nanodisk array on a glass substrate for LSPR biosensing applications. Based on above method, a large-area (~5 mm x 5 mm) and highly uniform nanostructure can be fabricated. The parameter of the nanostructure was determined according to finite-difference time-domain (FDTD) simulation. To perform real-time molecular sensing, the LSPR sensor was attached by a microfluidic channel and placed on a spectroscope. The sensitivity and FoM of the sensor are achieve 238 nm/RIU and 1.66, respectively. We also demonstrated the real-time and multi-point immunoglobulin (IgG) detection. Based on above features, we believe this platform has the potential for point-of-care (POC) applications.

……

FrB3.4 Nano-mechanic influence of the multi-photonic effects on metal decorated carbon nanostructures

Carlos Torres-Torres, Instituto Politecnico Nacional
Miguel Angel Sanchez-Salazar, Instituto Politécnico Nacional
Claudia Lizbeth Martínez-González, Instituto Politécnico Nacional
Cecilia Mercado-Zúñiga, Tecnológico de Estudios Superiores de Coacalco

This work is about the contribution of third-order nonlinear optical properties on the nano-mechanical behavior exhibited by multi-wall carbon nanotubes decorated by metal nanoparticles. The samples were explored in thin film form. The inclusion of monometallic Platinum, Gold and Silver in the carbon nanostructures was studied. Changes in mass density of around 1 μg/cm3 in the sample irradiated by light were numerically estimated. A vectorial two-wave mixing experiment was conducted with pulses provided by the second harmonic of a Nd:YAG laser system. The incorporation of metal nanoparticles in the carbon-based samples can provide advantages in opto-mechanic functions, regarding the sharp selective energy transfer that can be controlled by plasmonic phenomena. It is highlighted the potential of the optical Kerr effect for controlling opto-mechanic gate functions derived by changes in mass density in nonlinear optical systems.

……

FrB3.5 Yellow ceramic pigments from amorphous nanosized oxides using rice husk and zircon

Niti Yongvanich, Silpakorn Univ.
Tatpong Jitpagdee, Silpakorn Univ.
Bussakorn Chukaew, Silpakorn Univ.
Sunisa Papathe, Silpakorn Univ.

Nanosized SiO2 and ZrO2 powders extracted from rice husks and zircon minerals were used to synthesize yellow pigments. Both precursors possessed particles in the size of less than 100 nm. The yellow tone based on (Zr0.8Pr0.2)SiO4 was achieved and shown to be superior to those synthesized by conventional solid state processing. Such enhancement could be explained by a higher degree of cationic incorporation in the case of employing nanosized starting powders due to better reactivity. Various characterization tools were utilized to explain and clarify the obtained results. The performance of these pigments was tested in a real, industrial glaze within which the nano-based method demonstrated a higher level of stability in the molten glass. This comparative study was among the first to examine a change in coloration due to chemical interaction at the interface between the zircon-based pigment and the glaze.

……

FrC3 Nano Energy

Session Chair: Philippe Basset
16:30 - 18:00, Friday, April 12 (Room: Thai Boromphimarn 3, 3/F)

FrC3.1 A Tower-like Triboelectric Nanogenerator for Harvesting Ocean Wave Energy

Tiancong Zhao, Marine Eng. College, Dalian Maritime Univ.
Hukai Niu, Marine Eng. College, Dalian Maritime Univ.
He Wang, Marine Eng. College, Dalian Maritime Univ.
Song Wang, Marine Eng. College, Dalian Maritime Univ.
En Yang, Marine Eng. College, Dalian Maritime Univ.
Steven L. Zhang, School of Materials Sci. and Eng., Georgia Inst. of Tech.
Zhou Li, Beijing Inst. of Nanoenergy and Nanosystems, CAS, China
minyi xu, Marine Eng. College, Dalian Maritime Univ., Dalian, 116026, China
Zhong Lin Wang, School of Materials Sci. and Eng., Georgia Inst. of Tech.

Wave energy is regarded as the most promising energy sources in ocean. Here, we report a high power density triboelectric nanogenerator (TENG) based on a tower structure for harvesting wave energy from arbitrary directions. Such tower-like TENG (T-TENG) consists of multiple units made of PTFE balls and 3D printed arc surface coated with melt adhesive reticulation nylon film. The integration of power generation model with the kinetic model for the T-TENG is proposed and discussed. The T-TENG can effectively transform arbitrary directional wave energy into electrical energy by utilizing charged balls rolling on optimized arc surface induced by ocean wave excitation. Furthermore, an enhanced performance of power density increases linearly from 1.03 W/m3 to 10.6 W/m3 by increasing the units from 1 to 10 in one block. This indicates that the power density of the T-TENG increases proportionally with the number of units connected in parallel without rectifiers due to its distinctive mechanism and structure. Therefore, the design of T-TENG is considered as an innovative and effective approach for large-scale blue energy harvesting by connecting more blocks to form T-TENG networks.

……

FrC3.2 An Active Temperature Sensor based on Encapsulated Flexible and Transparent Triboelectric Nanogenerator

Ji Wan, Peking Univ.
Hao-Bin Wang, Peking Univ.
Li-Ming Miao, Peking Univ.
Hang Guo, Peking Univ.
Hao-Tian Chen, Peking Univ.
Xiao-Liang Cheng, Peking Univ.
Hai-Xia Zhang, Peking Univ.

In this paper, we fabricate a long-term stable flexible and transparent triboelectric nanogenerator(TENG) based on encapsulating hydrogel with polydimethylsiloxane(PDMS). This device not only can be employed for energy harvesting, but is able to detect the temperature as the resistance of the hydrogel encapsulated is changed with the temperature linearly. Therefore, from the principle, temperature sensing and energy harvesting are two independent functions in this design. Verified from the testing results, TENG reached an open-circuit voltage of 60V, a short-circuit current density of 14mA m-2, and a maximum power density at 0.225W m-2, and its temperature sensing range is 20-80℃ with sensitivity at 1.174%/℃ respectively.

……

FrC3.3 A Liquid-solid Interfacing Triboelectric Nanogenerator for High-sensitivity and Self-powered Ocean Wave Sensing

song wang, Marine Eng. College, Dalian Maritime Univ., China
minyi xu, Marine Eng. College, Dalian Maritime Univ., China
Steven L. Zhang, School of Materials Sci. and Eng., Georgia Inst. of Tech., United States
Wenbo Ding, School of Materials Sci. and Eng., Georgia Inst. of Tech., United States
Trung Kien Phan, Marine Eng. College, Dalian Maritime Univ., China
Chuan Wang, Marine Eng. College, Dalian Maritime Univ., China
Xinxiang Pan, Marine Eng. College, Dalian Maritime Univ., China
Zhou Li, Beijing Inst. of Nanoenergy and Nanosystems, CAS, China
Zhong Lin Wang, School of Materials Sci. and Eng., Georgia Inst. of Tech., United States

Wave monitoring is essential for marine engineering construction, development and utilization of ocean resources, maritime safety and early warning of marine disasters. In this paper, a high-sensitivity wave sensor based on liquid-solid interfacing triboelectric nanogenerator is proposed and systematically investigated. The wave sensor is made of a sensing copper electrode covered by poly tetra fluoroethylene film with nano-structured surface. Based on the electrical double layer and TENG theory, the relationship between the output voltage of WS-TENG and water wave conditions is established. It is found that the output voltage peak increases linearly with wave height at a sensitivity of 0.023 V/mm, but is independent of wave frequency. The output voltage decreases by increasing water salinity, due to high ions' concentration reduces induced charges in electrodes. In a water wave tank, the wave sensor is successfully used to monitor wave around offshore platform in real time. Therefore, the novel wave sensor provides an applicable approach to monitor wave for smart marine equipment.

……

FrC3.4 Multi-Functional Smart Textile - Energy Harvester and Sensors

Chengkuo Lee, National Univ. of Singapore

A smart textile fabricated with a simple dip coating method is developed with multiple functionalities, such as energy harvesting, physical sensing, and even gas sensing. To greatly extend the communication channels between humans and external devices in a natural way, here we report an intuitive, self-powered, low-cost, and glove-based interface based on the smart textile towards diversified applications. The glove-based interface has been successfully demonstrated for wireless car control, wireless drone control, minigame control, VR game control, and cursor control for online shopping as well as alphabet writing with a simple and intuitive operation technique.

……

FrD3 CM HO Best Paper Award in Micro/Nano Fluidics Finalist

Session Chair: Jin-woo Kim
16:30 - 18:00, Friday, April 12 (Room: Thai Boromphimarn 4, 3/F)

FrD3.1 Single-Bacteria Isolation and Selective Extraction Based on Microfluidic Emulsion and Sequential Micro-Sieves

Raymond H. W. Lam, City Univ. of Hong Kong

A high proportion of the human microbiota remains unknown, largely due to the large bacterial diversity in microbiome. The key technical challenge includes the single-bacteria isolation in order to extract individual bacterial strains from the microbial extracts. Here, a single-bacteria isolation and device is developed based on microfluidic emulsion for generating microdroplets to encapsulate single bacterium, followed by selectively extract the microdroplets for any downstream bacterial culture or analysis. Further application of this device will yield important new insights for deeper understanding of bacterial infections and general bacteriology.

……

FrD3.2 Automated Ionic Liquid Dispersive Liquid-Liquid Microextraction on a Centrifugal Microfluidic Platform

Yun Hui, Inst. of Electronics, CAS, China
Yujia Liu, Univ. of California, Irvine
William Tang, Univ. of California, Irvine
Ruiyi Chen, Univ. of California, Irvine
Marc Madou, Univ. of California, Irvine
Shanhong Xia, Inst. of Electronics, CAS, China

We aim to develop an automated platform to preconcentrate and separate trace-level substances in water sample, especially using ionic liquids as environmentally-friendly extractants. For the first time, automatically salt-controlled ionic liquid dispersive liquid-liquid microextraction on a centrifugal microfluidic platform is introduced. Red dye is chosen as a surrogate analyte to validate this method. The entire liquid transport and mixing process is controlled by rotation speed, siphon valves and capillary valves. Still frame images on the integrated compact disc are collected during the experiment to show detailed steps of the process, which consist of mixing, siphon priming, transportation between chambers, separation and collection. The red dye preconcentration results are clearly demonstrated and observable with the naked eye.

……

FrD3.3 DNA origami assembly in gradient tempareture microfluidic channel

Kentaro Kawai, Osaka Univ.
Keita Hara, Osaka Univ.
Kenta Arima, Osaka Univ.
Kazuya Yamamura, Osaka Univ.
Osamu Tabata, Kyoto Univ.

We present an effect of temperature distribution during a rapid folding of DNA nanostructures, called DNA origami. DNA origami can fabricate various designs and sizes of 2D/3D nanostructures by self-assembly of DNA hybridization. Based on results of computational fluid dynamics (CFD) simulation, time-dependent temperature

distribution in microtube effects the yield of DNA origami. Rectangle DNA origami can be folded at -20 °C/min, and triangle DNA origami can be folded at -30 °C/min in microfluidic channel whereas no DNA nanostructures were observed by general annealing process. We confirmed rapid self-assembly of DNA nanostructures in microfluidic channel (20 times in the rectangle DNA origami and 30 times in the triangle) compared to general annealing process in microtube by thermal cycler.

……

SaD1 Nanobiology and Medicine

Session Chair: Yu-Jui Fan
Session Co-Chair: Weiqiang Chen
11:10 - 12:40, Saturday, April 13 (Room: Thai Boromphimarn 3, 3/F)

SaD1.1 Self-powered System for Blood Separation and Coagulation Time Measurement

Jia Cheng Lin, School of Biomedical Eng., Taipei Medical Univ.
Thierry Burnouf, Graduate Inst. of Biomedical Materials and Tissue Eng., Taipei Medical Univ.
Yu Wen Wu, Graduate Inst. of Biomedical Materials and Tissue Eng., Taipei Medical Univ.
Yu Jui Fan, School of Biomedical Eng., Taipei Medical Univ.

In this study, a blood separation and the determination of blood condition without power supply was developed. First, using the concept of the design of the finger spinner and moment of inertia, fabricated a centrifugal blood separation device. A self-powered micro-channel device which is able to generate electrical signals by using triboelectric phenomenon was developed. When fluid flows through a solid surface, electrons are generated by friction between the liquid and the solid surface. The induction potential will be measured when the electrons accumulated at the solid surface. The device can be used to determine the coagulation time of the plasma. When the coagulation happens, the induction potential will be decreased. Combined the finger spinner centrifuge and a self-powered micro-channel, a blood condition detecting system without power can be formed.

……

SaD1.2 Nanoscale pearl powder exhibits non-peroxidase activity, fluorescence and inhibits cell spreading of prostate cancer

Madi Tilegen, Nazarbayev Univ.
Qinglei Sun, Qilu Univ. of Tech.
Ayan Nurkesh, Nazarbayev Univ.
Balnur Bazarbayeva, Nazarbayev Univ.
Haiyan Fan, Nazarbayev Univ.
Yingqiu Xie, Nazarbayev Univ.

Pearl powder is an ingredient in complex of traditional Chinese medicine in treatment on skin. However, how pearl powder affects cells especially cancer cells is unclear. Here we investigated the pearl powder electrochemical characters and biological functions. We found the major component of carbon and calcium with metals of Mn and Fe in pearl powder. The possible magnetic and non-peroxidase nanozyme activity suggest the complex functions of pearl powder in biological response. Moreover, the pearl powder at mixed nanoscale can inhibit cancer cells spreading and cancer cell growth, with differential pathways compared to normal cells. Our data suggest that pearl powder at mixed nanoscale can exert more efficient function in cells. Nano Chinese medicine may play complicated roles in therapy.

……

SaD1.3 The Design and Control of Magnetized Cell-Based Microrobots for Targeting Drug Delivery

Yanmin Feng, School of Mech. Eng. & Automation, Beihang Univ., Beijing Adv. Innovation Center for Biomedical Eng., Beihang Univ., China;
Dixiao Chen, School of Mech. Eng. & Automation, Beihang Univ.
Yuguo Dai, School of Mech. Eng. & Automation, Beihang Univ.
Yuanyuan Chen, School of Mech. Eng. & Automation, Beihang Univ., Beijing Adv. Innovation Center for Biomedical Eng., Beihang Univ.
Lin Feng, School of Mech. Eng. & Automation, Beihang Univ., Beijing Adv. Innovation Center for Biomedical Eng., Beihang Univ.;
De Gong, School of Mech. Eng. & Automation, Beihang Univ.

Cell microrobot is now a hot topic in medical for cell therapeutics and disease therapeutics. Cells can delivery various payloads for disease curation as vectors. However, the current problem is the low efficiency of controlling cells to the target tissue, which greatly limits the clinical applications of cell microrobot. Therefore, it is important to find a method to improve the efficiency of cell microrobot movement at the fixed point. Magnetic nanoparticle-labeled stem cells have become a mature and safe technology, so the use of external magnetic field targeting to control cell robot transportation is a very feasible solution. Here we proposed a new magnetized cell-based microrobots manufacturing method that can delivery drugs and nanoparticles. The magnetic cell-based microrobot can be discovered the best type of magnetic field response to rotating magnetic field motion to targeted delivery. In this study, we also built a magnetic control system platform which can control magnetic particles movement in three-dimensional direction.

……

SaD1.4 A Microfluidic Microwell Device Integrating Surface-enhanced Raman Scattering for Rapid Antibiotic Susceptibility Test of Blood-Borne Pathogen

Hsiu-Kang Huang, Graduate Inst. of Biomedical Eng. and Bioinformatics, National Taiwan Univ.
Nien-Tsu Huang, Dept. of Electrical Eng., National Taiwan Univ., Taipei, Taiwan

We have proposed a microfluidic microwell device integrating surface-enhanced Raman scattering (SERS) for rapid antibiotic susceptibility test (AST). By concentrating bacteria in the microwell, the effective bacteria concentration can increase 107-fold, which can eliminate prolonged cultivation time in conventional AST. For bacteria detection, SERS was integrated in the system to detect the Raman signal of secreted bacteria metabolites, which can be used for bacteria identification and antibiotic susceptibility test. In summary, our microfluidic microwell device integrating SERS platform enables a rapid and label-free bacteria identification followed by AST, which can be potentially used for real-time and rapid diagnosis of bacterial infectious diseases, such as sepsis.

……

SaD1.5 COMPARISONS OF PAP SMEAR CLASSIFICATION WITH DEEP LEARNING MODELS

Yuttachon Promworn, King Mongkut's Inst. of Tech. Ladkrabang
Chuchart Pintavirooj, King Mongkut's Inst. of Tech. Ladkrabang
Wibool Piyawattanametha, KMTIL
Satjana Pattanasak, Faculty of Sci. and Tech., Valaya Alongkorn Rajabhat Univ.

We presented an automated screening for cervical cancer screening via Pap smear method with deep learning technology which will eventually be implemented on our custom-built whole slide imager. The convolution neural network models were employed for detecting the presence of cervical precancerous or cancerous cells from a Pap smear database. The best deep learning model for multiclass classification is the

densenet161 with an efficiency of 68.0%.

……

SaE1 Micro/Nano Fluidics

Session Chair: Chia-Yuan Chen
Session Co-Chair: Raymond Lam
11:10 - 12:40, Saturday, April 13 (Room: Thai Borompbimarn 4, 3/F)

SaE1.1 Thread-based Electrospray Ionization Combining an Electrostatic Focus Ring for High Performance Mass Spectrometry Applications

Po-Hui Liu, National Sun Yat-sen Univ.
Che-Hsin Lin, National Sun Yat-sen Univ.

This work presents a novel thread-based electrospray ionization (ESI) combining an electrostatic focusing ring to enhance the total ion concentration and increase the detection limit of the mass spectrometry. A metal ring is placed between the thread tip for ESI and the inlet mass spectrometer to focus the ionized species with the applied electrostatic field. The ionized molecules are then pushed inward to the center of the ring while flying through the focus ring. The ion intensity for measuring the electrospray plumb can be greatly enhanced. Results showed that the measured total ion intensity is increased up to 5.3-fold for detecting 10 ppb of caffeine with a focusing electric field of 2.4 kV/cm. The sensing performance of the focusing was tested using caffeine and as sample molecule. The peak intensity for detecting 1.0 ppm of the T7 peptide chain is enhanced 6.8-fold and the calculated S/N ratio is 260 with an applied electric field of 2.6 kV/cm. The method developed in the present study provides a simple yet efficient way of enhancing the sensing performance of mass spectrometry.

……

SaE1.2 Apparatus of a light emitting diode utilizing a liquid conductor for dissipating heat and conducting electricity

Yung-Chiang Chung, Ming Chi Univ. of Tech.
Guang-Jun Zheng, Ming Chi Univ. of Tech.
Yao-De Xu, Ming Chi Univ. of Tech.

In this research, we replaced the solid conducting wire with a microfluidic channel and an electrolyte to conduct electricity and dissipate heat in a light emitting diode (LED). The optical power and temperature of the LED using three electrolytes, including salt, sodium bicarbonate, and citric acid were measured. The measured optical power was the highest when salt was used as the electrolyte. The temperatures of the LED and at the bottom of the microfluidic channel were much lower when a liquid conductor was used as compared to when a solid conducting wire was used. The optical power of the LED obtained using a solid conducting wire was higher than that obtained using a liquid conductor. The temperature decreased and optical power increased with increasing flow rate. We hypothesized that a liquid conductor with a lower electric resistance would improve the optical power of the LED.

……

SaE1.3 Innovative microfluidic-based technics for advance therapy medicinal product for the treatment of type-1 diabetes

Maxime Pierron, CEA Leti
Emily Tubbs, Universite Grenoble Alpes - LBFA
David Rabaud, CEA Leti
Camille Laporte, Universite Grenoble Alpes - LBFA
Magali Orhant-Prioux, EFS Auvergne Rhone Alpes
Cecile Cottet-Rousselles, Universite Grenoble Alpes - LBFA
Anaick Moisan, EFS Auvergne Rhone Alpes
Sandrine Lablanche, Universite Grenoble Alpes - LBFA
Florence Rivera, CEA Leti
Frederic Bottausci, CEA Leti

As part of the European consortium BIOCAPAN, we present an innovative advance therapy medicinal product for the treatment of type 1 diabetes and some severe cases of type 2 diabetes based on microencapsulation of insulin secreting islets. The aim of the microencapsulation of islets is to allow the patient to reach a 2-year-insulinindependent-period, without the need of immunosuppressant. We present here a method and apparatus for microencapsulation of human islets (Langerhans islets) in an innovative mix of biopolymers and biological elements. The mix allows biocompatibility and a suitable microenvironment that will minimize stress on the allogeneic transplanted islets while enhancing functionality and survival. The micro encapsulation is performed by an advanced equipment we developed that uses disposable encapsulation-oriented microfluidic cartridges. The system, complying with microfluidic standards, is a GMP (Good Manufacturing Practices)like equipment allowing a fully automated encapsulation process providing ready-to-implant microcapsules. This technology allows to process extremely viscous fluid (~10 Pa.s) and produce controlled monodisperse population of capsules.

……

SaE1.4 Blockable Structured Superomniphobic Surface Based on Doubly Re-entrant Topology

Meng-Shiue Lee, National Chiao Tung Univ.
Dazhao Dong, National Chiao Tung Univ.
Tsung-Hsiu Tsou, National Chiao Tung Univ.
Yu-Shin Lin, Instrument Tech. Res. Center
Wensyang Hsu, National Chiao Tung Univ.

The blocking process is one of the standard steps in the conventional immunoassay analysis to enhance the detection sensitivity by reducing the background noise. However, the blocking process will turn the surface coating with hydrophobic material to be hydrophilic, which will deteriorate the fluidic manipulation capabilities. Therefore, in microfluidic devices, it is hard to integrate the standard blocking process without compromising the hydrophobic property. This paper presents a blockable structured superomniphobic surface based on the doubly re-entrant topology. It is shown that, after immunoassay analysis with the blocking process, the proposed surface has 62 times lower background noise than the conventional hydrophobic coating surface, while maintaining excellent liquid repellency for fluidic manipulation. The proposed surface exhibits excellent liquid repellency and lower background noise even after surface blocking process, which is unachievable by other hydrophobic materials or structured surfaces.

……

SaE1.5 Cell Detection in Microfluidic System by Terahertz Technique

Sung-Yen Pao, Dept. of power Mech. Eng., National Tsing Hua Univ., Taiwan
Shih-Jie Lo, ACE Solution Co., Ltd., 2F-1, No. 28, Taiyuan St., Zhubei City, Hsinchu Country 30288, Taiwan.
Kai-Yuan Tang, ACE Solution Co., Ltd., 2F-1, No. 28, Taiyuan St., Zhubei City, Hsinchu Country 30288, Taiwan.
Steve Hsu, ACE Solution Co., Ltd., 2F-1, No. 28, Taiyuan St., Zhubei City, Hsinchu Country 30288, Taiwan.
Jeffrey YAO, National Tsing Hua Univ.

This paper reports a microfluidic system designed and used for cell detected by terahertz (THz) technique. The terahertz wave signal, generated by photoconductive antenna, penetrates through cells, medium, and the materials of the microfluidic device. Terahertz wave has advantages of high transmission to non-conducting materials, high spatial resolution, and low power, so it can measure and identify the difference among materials with a non-invasive detection. The great virtue of terahertz detection is that it won't cause radiation injury to

normal cells. The experiment results demonstrate the capability to differentiate between various kinds of solutions. After injecting cells and medium into the microfluidic device, this approach can help us to distinguish the cancer cells among normal cells in the future.

……

SaC2 Nanomaterials 2

Session Chair: Carlos Torres
Session Co-Chair: Pengyu Chen
14:00 - 15:30, Saturday, April 13 (Room: Thai Chakkraphat 3, 2/F)

SaC2.1 Controlled synthesis of hydroxyapatite nanoparticles

Aditya Abburi, Mahindra Ecole Centrale
Visweswara Rao Abburi, AV Tech. Consultants Pvt Ltd

The objective of this study was to overcome the present limitations in manufacturing processes of nanomaterials. Hydroxyapatite nanoparticles with uniform size were successfully fabricated, the source of phosphorous being commercial grade phosphoric acid and mono calcium phosphate. The process not only yielded pure nanoparticles but also demonstrated that it is possible to alter shape and surface charge of the products. The hydroxyapatite nanoparticles were examined by DLS, XRD, and FESEM. The effect of Ca P strength, rate of agitation and pH of solution on hydroxyapatite particle size was studied. The experiment results indicate that by changing the experimental conditions, it is possible to engineer the characteristic of hydroxyapatite nanoparticles for various applications.

……

SaC2.2 Atomic Force Microscopy Study of Non-covalently functionalized CVD Graphene

Abayomi Omolewu, Microelectronics-Photonics Graduate Program, Univ. of Arkansas
Guangyi Shi, Scics, Peking Univ. at Wuxi, Wuxi, China.
Dr. Uche Wejinya, Univ. of Arkansas
Xiangbo Meng, 4Dept. of Mech. Eng., Univ. of Arkansas, USA
Ryan Tian, Dept. of Chemistry and Biochemistry, Univ. of Arkansas,

Chemical functionalization is a method that is been explored to take advantage of the intriguing properties of graphene and other graphitic materials. Surfactant treatments have been successfully employed to non-covalently functionalize graphitic materials such as carbon nanotube and graphite. However, there is still need to investigate the surfactant treatment approach for commercially available chemical vapor deposited (CVD) graphene on silicon-silicon dioxide substrate. CVD graphene is one of the large-scale graphene available; hence, it is essential to understand how surfactants interact with it. This work presents the atomic force microscopy study of non-covalently-functionalized graphene using Sodium Dodecyl Sulphate. CVD graphene on silicon/silicon dioxide (Si/SiO2) substrates were treated with different surfactant concentrations for different times. Unlike other derivatives of graphene, like carbon nanotube where the detachment of the graphene is not a concern, results show that the stability of the CVD graphene on the substrate is highly dependent on the concentration of the surfactant used for modifying the surface of the graphene. Higher concentration of surfactant treatment was achieved by dissolving the surfactant with water and isopropyl alcohol. The result also suggests that different concentrations of surfactant affect the surface roughness of the functionalized graphene.

……

SaC2.3 Thermal Parameters Determination Through Thermoreflectance Measurements and Analysis

Elie BADINE, Université du Littoral Côte d'Opale
Mathieu BARDOUX, Université du Littoral Côte d'Opale
Nadine ABBOUD, Université Libanaise
Ziad HERRO, Université Libanaise
Abdelhak HADJ SAHRAOUI, Université du Littoral Côte d'Opale

In this work, we describe a new approach for the measurement of the thermal properties of a thin film by applying the thermoreflectance technique. The experimental results are fitted on a developed model in order to obtain the required properties. The major novelty value of this new procedure is the possibility to determine simultaneously the thermal diffusivity and conductivity of a thin film as well as the thermal boundary resistance with only one experimental measurement. Hence, an important and precise tool is obtained and it can be applied in a wide range of thermal studies. We believe that this work is a new possibility offered to the specialists of the field of condensed matter and related nanostructures to characterize their samples and thus contribute to the development of measurement methods, essential for developing new materials. Our paper creates a paradigm for future studies of thermal characterization in a multilayer sample.

……

SaC2.4 All Organic, Conductive Nanofibrous Twisted Yarns

P. Vishakha T. Weerasinghe, Univ. of Moratuwa
Nandula D. Wanasekara, Univ. of Moratuwa
Geetha Dissanayake, Univ. of Moratuwa
H.M.Ravindu T. Bandara, Univ. of Moratuwa
Nadeeka D. Tissera, Sri Lanka Inst. of Nano Tech.
Ruchira N. Wijesena, Sri Lanka Inst. of Nano Tech.
K.M. Nalin de Silva, Sri Lanka Inst. of Nano Tech.
Anushanth Karalasingam, Sri Lanka Inst. of Nano Tech.

The field of smart textiles is becoming a promising approach in wearable technologies where electronic properties are incorporated into fibers rather than connecting electronic components to apparel products. This research was aimed on achieving conductivity by blending in a conductive polymer with a carrier polymer to produce nanofibrous yarns using electrospinning. Camphor sulfonic acid doped polyaniline (PANi-CSA) was blended with polyacrylonitrile (PAN) to produce aligned nanofibrous webs. Then fiber stripes were twisted in the S direction to obtain twisted yarns having a twist level of 2 twists per meter (tpm). The twisted single yarns were utilized to prepare plied yarns. The fiber morphology and electrical properties were studied by varying the number of plies. In addition, a continuous nanofibrous yarn production set up was developed to prepare continuous twisted PAN/PANi nanofibrous yarns. Material properties of the twisted yarns were observed as a function of post processing conditions such as stretching and annealing. It is envisaged that this research would lead to the continuous production of all organic, conductive nanofibrous yarns with potential applications in smart textile such as 3D woven or knitted tissue scaffolds, pH sensors and electrical heating elements

……

SaD2 Sensors and Actuators

Session Chair: Shuo Gao
14:00 - 15:30, Saturday, April 13 (Room: Thai Boromphimarn 3, 3/F)

SaD2.1 Smith Matching for CMUTs-based Biochemical Resonant Sensor

Yihe Zhao, Xi'an Jiaotong Univ.
Libo Zhao, Xi'an Jiaotong Univ.
Rahman Hebibul, Xinjiang Vocational & Technical College of Communications
Zhikang Li, Xi'an Jiaotong Univ.
Jie Li, Xi'an Jiaotong Univ.
Tingzhong Xu, Xi'an Jiaotong Univ.

Shuaishuai Guo, Xi'an Jiaotong Univ.
Jiuhong Wang, Xi'an Jiaotong Univ.
Yulong Zhao, Xi'an Jiaotong Univ.
Zhuangde Jiang, Xi'an Jiaotong Univ.

Abstract—A LC smith matching method for capacitive micromachined ultrasonic transducers (CMUTs) was presented for biochemical application. We completed the fabrication of CMUTs based on the direct bonding technology. A modified Butterworth van-Dyke (BvD) model with lumped elements for functionalized CMUTs were proposed to fit the electrical impedance and phase of CMUTs, which were accurately measured by the impedance analyzer. The series and parallel frequencies of CMUTs were obtained. It is difficult for the functionalized CMUTs to achieve the transmission from capacitive reactance to inductive reactance at relatively low DC voltage. And the proposed LC matching network can optimize the properties of impedance, phase, resistance, especially reactance near the resonant region. This is important for the real-time oscillator design, which needs strict condition for the Barkhausen stability criterion of gain and phase.

……

SaD2.2 NARMAX Modeling for Hysteresis of Magnetical Shape Memory Alloy Actuator

Yewei Yu, College of Communication Eng., Jilin Univ.
Chen Zhang, College of Communication Eng., Jilin Univ.
Miaolei Zhou, College of Communication Eng., Jilin Univ.

Magnetical shape memory alloy (MSMA) based actuator is extensively applied in the fields of precision manufacturing and micro-nano technology. Nevertheless, the inherent hysteresis in the MSMA-based actuator severely impacts its further application. The hysteresis loop of the MSMA-based actuator possesses the asymmetrical, wide saturated and ratedependent characteristics. In this research, we firstly investigate the characteristics of hysteresis behavior under the persistent excitation signal. Then a novel nonlinear auto-regressive moving average with exogenous inputs (NARMAX) model based on diagonal recurrent neural network (DRNN) is used to construct the rate-dependent hysteresis model. Play operator is first introduced as an exogenous variable function in order to improve the capability of characterizing the multi-valued mapping of hysteresis loop of the MSMA-based actuator. To verify the effectiveness of the proposed model, a series of comparisons are implemented. The results show that the proposed NARMAX model based on DRNN has excellent modeling precision.

……

SaD2.3 Wearable Breathing Sensor Utilizing CNT Shelled Oxidized Poly-Naphthalene Composite

Ying Shen Lai, National Sun Yat-sen Univ. The Dept. of Mech. and Electro-Mech. Eng.
Po Yu Yang, National Sun Yat-sen Univ.
Ju Shin Pon, National Sun Yat-sen Univ.
Che-Hsin Lin, National Sun Yat-sen Univ.

Carbon nanotubes (CNTs) shelled oxidized poly naphthalene (OPN) composite sensing film is developed in this study. Commercial PCB substrate with 30 μm pitched interdigital electrodes is sprayed coated with 0.1 WT % of multiwall CNTs as the seed layer for plasma-induced growing oxidized poly-naphthalene as the humidity sensing layer. The carboxyl groups in the oxidized poly-naphthalene exhibit good resistance response to the water molecules such that the developed CNTs-OPN file is a good candidate for humidity sensing applications. The respiration response for a volunteer at quiet and after an intensive exercise is successfully detected.

……

SaD2.4 Surface-Enhanced Raman Spectroscopy with Gold Nanoparticle Dimers Created by Sacrificial DNA Origami Technique

Naoki Yamashita, Kyoto Univ.
Seongsu Park, Kyoto Univ.
Kentaro Kawai, Osaka Univ.
Yoshikazu Hirai, Kyoto Univ.
Toshiyuki Tsuchiya, Kyoto Univ.
Osamu Tabata, Kyoto Univ.

In this study, gold nanoparticle (AuNP) dimers for surface enhanced Raman spectroscopy (SERS) were formed by DNA origami and then DNA origami was selectively removed from the silicon chip. The state of decomposition of the DNA origami between couples of AuNP pair were checked by SERS analysis in air and no noise from DNA origami was observed after the cleaning process. In molecular trace analysis using AuNP dimers, the SERS signals from the 4,4'-bipyridine target molecule in water were successfully detected.

……

SaD2.5 Analysis of RF MEMS Thermoelectric Power Sensors with Different Resistor Sizes

Chenlei Chu, Key Lab. of MEMS of the Ministry of Education, Southeast Univ.
Xiaoping Liao, Key Lab. of MEMS of the Ministry of Education, Southeast Univ.

This paper presents a series of RF MEMS thermoelectric power sensors with different resistor sizes and compares their characteristics. All the adopted thermopiles have same structure sizes to eliminate the influences of thermopiles. What's the difference is that we employ six couples of TaN resistors of 50 Ω but with different sizes. The proposed RF MEMS thermoelectric power sensors are fabricated using GaAs MMIC technology. Measurement results show that the sensitivities of sensors A1-A6 are 81 μV/mW, 70.6 μV/mW, 62.4 μV/mW, 58.1 μV/mW, 51.9 μV/mW and 46.7 μV/mW, respectively. This indicates that as the size increases, the corresponding sensitivity has a decrease. This is mainly because that the temperature field of large size resistor affect the temperature of cold area.

……

SaD2.6 SERS Measurements On Platinum Nanoparticle Under Influence Of Oscillating Electric Dipole Field

Viveka Br, Sai Vidya Inst. Of Tech.

SERS is in demand for bio / chemical molecular detection. Enhancement effect of SERS depends on surface plasmon resonance. In our experiment plasmonic nanoparticle of platinum was exposed to oscillating electric dipole field. Experimental results show that enhancement factor can be increased manyfold thereby improving the bio / chemical sensor performance. Experiments suggest a novel approach to obtaining very high enhancement factors (EF).

……

SaPo1 Poster Session 2

Session Chair: Cecil Chen
Session Co-Chair:
14:00 - 15:30, Saturday, April 13 (Room: Thai Boromphimarn 4, 3/F)

SaPo1.1 Liquid Metal-Based Manipulator for Microscale Handling Inside SEM

Fabian von Kleist-Retzow, Univ. of Oldenburg

Malte Bartenwerfer, Univ. of Oldenburg
Sergej Fatikow, Univ. of Oldenburg

In this paper, the application of liquid metals is demonstrated in adhesive bond handling for micro-manipulation. Using the possibility to switch gallium between a liquid, lowadhesion state and a solid, high-adhesion state by phase changes enables to tune force equilibria at manipulators. Based in this possibility, reproducible pick and place operations become feasible. We present an experimental setup that is capable of handling arbitrarily shaped objects inside the SEM using robotic fine-positioning stages and a customized manipulator. A phase changing liquid-metal manipulator is used in a six-step pick and place method, that is successfully demonstrated in an experiment. A general analysis of uncertainties and challenges of this method is presented which identifies bottlenecks of the presented process.

……

SaPo1.2 An Optimized Clocking Scheme for Nanoscale Quantum-dot Cellular Automata Circuit

Lei WANG, Hefei Univ. of Tech.
Guangjun Xie, Hefei Univ. of Tech.
Renjun Zhu, Hefei Univ. of Tech.
Chen Yu, Hefei Univ. of Tech.

Quantum-dot cellular automata (QCA) is an emerging and developing technology, which is characterized by ultra-fast switching frequency, ultra-dense manufacturing and low power dissipation compared to CMOS technology, so QCA is one of the attractive alternatives to the current conventional CMOS. With the development of QCA technology, the automation technology for nanoscale QCA circuit design process has been extensively studied. In this work, a novel two-dimensional timing scheme with large clock region, suitable feedback loop, plain layout and non-crossing underlying structure was presented. The proposed novel two-dimensional timing scheme in this work not only to solve the clocked metal wire crossing problems, but also significantly reduce the difficulty of the manufacturing, compared with the existing optimal timing scheme. Finally, in order to prove the superiority of the proposed timing scheme, several circuits were implemented based on the proposed timing scheme by using QCADesigner. And it demonstrates that the area and the latency of the circuits are improved compared with circuit using the existing typical timing schemes.

……

SaPo1.3 Modeling and Identification for the Nonlinearity Hysteresis of Piezoelectric Actuators

Lu Zhou, Nankai Univ.

Piezoelectric actuator (PEA) has low driving power, wide operating frequency, high displacement resolution and high control accuracy, which is an excellent microscale actuator. However, the hysteresis significantly of piezoelectric ceramics is a problem which make a great influence on accuracy. On the basis of modeling the hysteresis characteristics, compensation for it is the key to solve this problem. In this paper , it is found that hysteresis exists not only in nonlinear systems but also in some linear systems. The measured hysteresis of PEA exhibits strong rate-dependence and saturation phenomena, increasing the difficulty in the hysteresis modeling and identification. In this paper, a new hysteresis model of piezoelectric ceramic actuator is proposed. Based on this, the paper analyzes a large number of experimental data, models the hysteresis of the voltage before and after the power amplifier, and uses a modified Prandtl-Ishlinskii (PI) model for hysteresis of the input voltage and the output distance. Experimental results show that the composite model to more accurately describe the hysteresis characteristics of piezoelectric ceramic actuators over a wide rate-range.

……

SaPo1.4 A New Model for Simulating Spindle Asymmetic Division Mediated by Cortical Actin

Yuan Huang, Nankai Univ.
Lin Liu, College of Life Sci., Nankai Univ.
Xin Zhao, Inst. of Robotics and Automatic Info. System and Tianjin Key Lab. of Intelligent Robotics, Nankai Univ.

Cell division is an important and fundamental process which is contributed to cell proliferation and differentiation. For mammalian, female meiotic divisions are typically asymmetric, generating two kinds of daughter cells with unequal size. This mechanism is essential to retain sufficient storage material for the development of embryo after fertilization. In order to achieve asymmetric division, the most crucial procedure is the migration of spindle from the center to cortex in meiosis I. In this paper, we used a set of PDEs with two reacting and diffusing chemical morphogens and adding another substance to represent cortex actin to investigate the mechanism of spindle movement in meiosis I. According to our simulation result, our hypothesis showed good consistency with real division process.

……

SaPo1.5 Au-PET based Formaldehyde Vapor Sensor

Olaoluwa Akinsola, UMBC
Ricardo Cardoza, UMBC
Makayla Headley, UMBC
Gymama Slaughter, Univ. of Maryland Baltimore County

Various factors threaten the longevity of the art displays in museum environment. Factors such as temperature, humidity, and volatile organic compounds can compromise the aesthetic and structural make-up of the art pieces, thereby significantly impacting the cost of art restoration. Among the many vapors found in a museum environment, formaldehyde is especially hazardous because of its deleterious effect on art pieces. Here, we present the fabrication of a flexible gold sputtered polyethylene terephthalate (PET) electrode for the detection of formaldehyde. The electrode was chemically modified with carboxylic acid-functionalized multi-walled carbon nanotubes (MWCNTs) and ruthenium oxide as the sensing element. A signal conditioner circuit was built and integrated with the sensor in order to regulate the current flowing to the sensor. Resistance characterizations demonstrated that these thin film Au-PET sensors respond to the exposure of vaporized formaldehyde, wherein a sharp increase in resistance is observed immediately. The observed response returned to the baseline resistance upon the removable of formaldehyde vapor. This response demonstrated the sensor's ability to detect formaldehyde vapor as well as its reversibility.

……

SaPo1.6 In vitro microfluidics-based blood–brain barrier model

Ya-Yu Chiang, Dept. of Mech. Eng. National Chung - Hsing Univ.
Kai-Hung Tu, No.145, Xingda Rd., South Dist

Organ-on-chips model is a microengineering system that contain the microchannels and can replicate the living condition in vivo to build up a tissue in vitro. It has the benefits to construct the user-friendly platform for the further biological experiment. We demonstrate a low-cost 2D organ-on-chip model which mimic the blood brain barrier (BBB) tissue is designed as a platform for clinical testing, such as drug delivery, substances cytotoxicity. To fabricate the microchannel, a MEMS-based mold was fabricated for the further process. The channel was completely transparent and can offer the advanced visibility. After the cell seeding on the chip, the medium injection was started and we use the continuous flow to mimic the hydrodynamic shear stress to form the tissue. We will

describe the shear stress effect on the cell morphorlogy and also will discussed the angle between cell growing directions and flow direction after affected by shear stress.

……

SaPo1.7 MEMS Piezoelectric Vibration Energy Harvester with In-Plane PZT Bimorph

Lu Wang, Xi'an Jiaotong Univ.
Libo Zhao, Xi'an Jiaotong Univ.
Zhuangde Jiang, Xi'an Jiaotong Univ.
Xiang Li, Xi'an Jiaotong Univ.
Zihang Chen, Xi'an Jiaotong Univ.
Maeda Ryutaro, Xi'an Jiaotong Univ.

In order to overcome the drawbacks of conventional out-plane vibration MEMS-PVEH. We have presented an in-plane vibration MEMS-PVEH with bimorph PZT by bonding bulk PZT. Performance of two kinds of PVEHs were studied by finite element method using COMSOL software. Including vibration modes, resonant frequencies, open circuit voltage, peak power, optimal resistance, and the static stress at gravity load of the structure. Compare to the conventional out-plane vibration PVEH, the proposed in-plane vibration PVEH has lower resonant frequency of 122 Hz, higher peak power of 50 μW. It has advantages of heavier proof mass, good performance PZT bimorph, thinner cantilever thickness, convenient electrodes lead, and has the frame to protect the oscillator. Besides, in-plane vibration PVEH is convenient to be fabricated by planar graphical MEMS process.

……

SaPo1.8 Utilizing TD-GC-MS System and Gas Sensor Array based on Surface Acoustic Wave for Red Wines Discrimination

Hsin-Yen Lin, National Tsing Hua Univ.
Min-Han Lin, National Tsing Hua Univ.
Da-Jeng Yao, National Tsing Hua Univ.

According to previous work, many researches used GC-MS to analyze the aroma of red wines and further find the marker volatile organic compounds (VOCs) which can differentiate red wines of different varieties of grapes. However, less research distinctly used surface acoustic wave (SAW) gas sensor to discriminate red wines of different varieties of grapes. In this research, at first, we used TD-GC-MS system to find the marker VOCs. Then, we selected proper polymers which have strong affinity to marker VOCs depending on the hydrogen bond and van der walls force. Therefore, we utilized SAW gas sensor array which was coated with various polymers to distinctly discriminate the red wines. Besides, in order to increase credibility, we conducted the blind test and successfully distinguished red wines.

……

SaPo1.9 Hydropower Energy Harvest By Triboelectric Nanogenerator Performed In Droplet-Based Microfluidic System

Hsuan-Yu Lin, National Tsing Hua Univ.
Da-Jeng Yao, National Tsing Hua Univ.
Zong-Hong Lin, National Tsing Hua Univ.

With the advancement of technology, lightness and miniaturization of components, and multi-functional wearable electronic devices are widely developed. The self-powered system of triboelectric nanogenerators (TENGs) developed in recent years have been paid attention. It can be used as a continuous energy source for wearable electronic devices. However, most of TENGs are made of solid-solid materials, and few solid-liquid TENGs are used as hydropower energy harvesting. A nanogenerator by combining the principles of triboelectric and electrostatic induction has been developed with the droplet-based microfluidic system. The measurement of our device can go up about 5 to 10 mV that help us to develop a tiny generator to apply in human body like artificial heart.

……

SaPo1.10 Development of Large-scale Controllable Nanopillar and Biosensing Applications Based on Self-assembly Technology

Qi Qi, North China Univ. of Tech.
Anjie Ming, State Key Lab. of Adv. Materials for Smart Sensing, General Res. Inst. for Nonferrous Metals
Shuhua Wei, North China Univ. of Tech.
Lidong Wu, Minisrty of Agriculture,Chinese Academy of Fishery Sci.
Jing Zhang, North China Univ. of Tech.
Lintao Liu, Inst. of Microelectronics, CAS, China
Chunhui Liu, North China Univ. of Tech.
Jiang Yan, North China Univ. of Tech.
Weibing Wang, Inst. of Microelectronics, CAS, China

This study presents the fabrication of the ordered nanostructures which use the self-assembly monolayer of polystyrene spheres (PS) as the mask and its potential application on biosensors. This work demonstrates the effect of the ratio of Ethanol in polystyrene suspension on the self-assembly monolayer process. Ethanol is used to assist the formation of large-scale monolayer. Using the Reactive Ion Etch (RIE) to reduce the diameter of polystyrene spheres by adjusting the process parameter of power and gas flow can control the size of self-assembly monolayer as masks, which can define the size of the nanostructure. Finally, this study fabricated nanostructures for more than 1 μm by RIE, which proves the feasibility of the technique to be applied to biosensors.

……

SaPo1.11 MoS2-based Transistors for Flexible Sensors

Guangcun SHAN, Beihang Univ.
Xin Li, Beihang Univ.
Yi Xu, City Univ. of Hong Kong
Wei Huang, Nanjing Tech Univ. and Northwestearn Polytech Univ.

Abstract—This work reports a high performance flexible thin-film transistor (TFT) array based on the MoS2 thin film channel and rGO electrodes. The obtained device shows high flexibility and excellent reproducibility from device to device. The TFT array is used as high-performance, easy-operable and robust gas sensors for the NO2 detection. Superior sensitivity of the MoS2-based device is observed. Functionalization of the MoS2 thin film with Pt nanoparticles can further increases the sensitivity by ~3 times. A high detection limit of 2 ppb is achieved by using the functionalized MoS2 as channel. Our work here suggests that the high-quality and solution-processable single-layer MoS2 is a promising channel material used for the practical electronic sensors.
Keywords—MoS2 thin film, sensor, devices

……

SaPo1.12 multifunctional flexible strain sensor based on the ionogels and its application in monitoring the human motions

Zhang Yunlin, Soochow Univ.
Wang Fengxia, Soochow Univ.
Chen Tao, Soochow Univ.
Yang Zhan, Soochow Univ.
Sun Lining, Soochow Univ.

In summary, multifunctional flexible and wearable piezoresistive sensor was reported using microporous ionogels as sensing layer, which was fabricated simply by thermal polymerization of ([VEIm][DCA]) ionic liquid(IL) and micro-fabrication method. The high conductive microporous structure was first fabricated by the facile method and used as the strain sensor active layer to improve the sensitivity. The fully flexible strain sensor based on simple sandwich structure using the microporous ionogel and flexible substrate could well adhere to human skin. The electrical characteristics under different external conditions

were studied. The result indicated that the obtained sensors could sensitively respond to pressure, tension and temperature signals separately. Importantly, the sensing platform with high sensitivity and excellent biocompatibility enabled to monitor the human activities, human health, and human-machine interaction. Besides, the polymerized ionogels also process self-healing capability which could extend the working time of the strain sensors significantly. The facile fabrication and the versatile capabilities of the sensing platform made it promising candidate in wearable sensors.

……

SaPo1.13 Study of Hollow Nanoneedle's Mechanical Performance by Nanorobotic Manipulation System

Wanfeng Shang, Shenzhen Inst. of Geriatrics
Chunbao Wang, Shenzhen Inst. of Geriatrics
Zhengzhi Wu, Shenzhen Inst. of Geriatrics

Micro/nanomanipulation is becoming an indispensable research approach in cellular field, biomedicine, micro-robot and material mechanical engineering. With the improvement of automatic operation system, more attention also need to be focused on selecting a suitable nanotool to achieve the manipulation task. This paper studied two hollow glass nanoneedles to analyze their mechanical properties, which were fabricated from borosilicate capillaries with two different tip diameter. A reference atomic force microscope (AFM) cantilever has been utilized for testing the nanoneedle's bending force in a scanning electron microscopy (SEM) by home-made nanorobot. The proposed nanorobotic manipulation system utilized in this work has been developed with 3-degree-of-freedoms (DOF), which are composed of three high precision linear positioners installed perpendicular to each other. The hollow nanoneedle's bending test has been conducted with the help of the 3-DOFs nanorobotic manipulation system. As a result, the borosilicate nanoneedle shows larger bending strength with larger tip diameter. As a desired tool on account of glass' chemical durability, the nanoneedles' different performances in mechanical properties pave a stable way in nanotools' option.

……

SaPo1.14 Motion control of nanomanipulation platform based on feedforward compensation inside SEM

Mingyu Wang, Mech. and Electrical Eng. Soochow Univ.
zhan yang, Jiangsu Provincial Key Labratory of Adv. Robotics & Collaborative Innovation Center of Suzhou Nano Sci. and Tech., Soochow Univ.
Tao Chen, Jiangsu Provincial Key Labratory of Adv. Robotics & Collaborative Innovation Center of Suzhou Nano Sci. and Tech., Soochow Univ.
Lining Sun, Jiangsu Provincial Key Labratory of Adv. Robotics & Collaborative Innovation Center of Suzhou Nano Sci. and Tech., Soochow Univ.
Toshio Fukuda,

With the rapid development and wide application of nanotechnology, nanodevice manufacturing with nanotechnology as its core has become one of the key research areas in nanotechnology. Micro-nano operating system based on scanning electron microscope (SEM) is one of the methods to realize nanodevice manufacturing. SmarAct nanomanipulation platform is an important component of micro-nano operating system, which can realize linear motion in three-dimensional space. However, due to mechanical structure and assembly errors, the SmarAct nanomanipulation platform cannot meet the stable requirements during motion. In this paper, the visual feedback and image processing are used to describe the motion trajectory of SmarAct operator. Based on the motion mechanism of SmarAct operator, the error source is analyzed, at the same time, the motion error is modeled according to the motion trajectory. The feedforward compensation is used to realize the stable linear motion of SmarAct operator, and the interpolation algorithm is used to realize the trajectory motion control of the SmarAct nanomanipulation platform.

……

SaPo1.15 N-functionalized Graphene Quantum Dot Downconverters for Cu(In,Ga)Se2 Solar ells

Jae Hyun Kim, DGIST
Firoz Khan, DGIST

Copper indium gallium selenide (CIGS) is the most promising thin film solar cell technology. However, its high performance is hampered by its poor short-wavelength response. The short-wavelength response can be enhanced via photon downconversion using quantum dots. Unfortunately, most graphene quantum dots (GQDs) are not suitable as downconverters in CIGS cells owing to their low photoluminescence quantum yield (PL QY) and/or low Stokes shift. Herein, an ultrahigh PL QY (99%) and a large Stokes shift (98 nm) are achieved for N-doped GQDs via a novel method. The performance of a CIGS solar cell is enhanced via photon downconversion and the light trapping effect using the NGQDs. The effectiveness of the NQGDs is manifested in a conversion efficiency (η) of 15.31%. In addition, improvements in the short-circuit current density from 30.69 mA/cm2 to 31.77 mA/cm2 and fill factor from 71.25% to 73.09% are observed. The n and J0 values are decreased by insertion of NGQDs, indicating a reduction in the recombination losses.

……

SaPo1.16 Cooperative Carbon Nanotube Nanomanipulation For Field Effect Transistor

Donglei Chen, Soochow Univ.
zhan yang, Jiangsu Provincial Key Labratory of Adv. Robotics & Collaborative Innovation Center of Suzhou Nano Sci. and Tech., Soochow Univ.
Tao Chen, Jiangsu Provincial Key Labratory of Adv. Robotics & Collaborative Innovation Center of Suzhou Nano Sci. and Tech., Soochow Univ.
Lining Sun, Jiangsu Provincial Key Labratory of Adv. Robotics & Collaborative Innovation Center of Suzhou Nano Sci. and Tech., Soochow Univ.
Toshio Fukuda,

In this paper, based on the operating environment of scanning electron microscope (SEM), the cooperative control of carbon nanotubes by controlling multi-operator hand was realized by controlling the robot operator with multiple degrees of freedom. Firstly, the carbon nanotube was picked up from the bulk by the nano manipulations. Then the nanotube was transferred on the surface of the metal electrode of the chip using the two nano manipulations and fixed on by electron beam induced deposition (EBID). In this robotics manipulation system, operation and assembly of carbon nanotube were successfully realized. The voltage-current property of the carbon nanotube was also evaluated in the SEM.

……

SaPo1.17 Hundred body length velocity self-actuating platinum micromotor in H2O2

gu chenyi, soochow Univ.
zhan yang, Jiangsu Provincial Key Labratory of Adv. Robotics & Collaborative Innovation Center of Suzhou Nano Sci. and Tech., Soochow Univ.

Catalytic micromotors exhibit self-propulsion in the presence of chemical fuels such as hydrogen peroxide, glucose. Generally, micromotors use a catalyst as a part of their structure for the decomposition of a chemical fuel. Several applications such as active drug delivery, minimally-invasive surgery, and water remediation, have

been envisaged. In the paper, high speed platinum micromotor in hydrogen peroxide (H2O2) solution was reported. Platinum micromotor was fabricated by template electrochemical deposition in 1 g/L H2PtCl6 and 30 g/L H3BO3 solution. The length and diameter of the micromotor are about 2.5 μm and 0.4 μm. The speed of the micromotor was up to 365 μm/s in 20% H2O2 solutions.

……

SaPo1.18 Graphene Layer Preventing and Controlling Nano-Wear of Semiconductor Substrate

Qi Zhang, School of Mech. Eng., Xi'an Jiaotong Univ., China
Yulong Zhao, School of Mech. Eng., Xi'an Jiaotong Univ., China

Graphene is a promising material for micro-electro-mechanical system (MEMS) and nano-electro-mechanical system(NEMS). Nano-wear of micro surfaces leads to significant impact on the performances of nano devices, and many researchers make great efforts to find various materials controlling nano-wear.Molecular dynamics is used to study the effect of adhesion on material transfer during wear of nanoscale sliding contacts. Material transfer is quantified in terms of the number of atoms transferred from a copper substrate to a silicon dioxide tip where the interaction strength between the two materials is varied to modulate the work of adhesion. Material transfer and the effect of adhesion on that process are evaluated before sliding and after sliding, and at a range of normal loads. Results reveal that both adhesive and abrasive wear mechanisms contribute to material transfer during sliding, but that the relative contributions of those two mechanisms depend on the applied load and work of adhesion.

……

SaPo1.19 Nanoscale avalanche magneto-diode

Jinki Hong, Dept. of Display and Semiconductor Physics, Korea Univ.
Taeyueb Kim, Center for Electricity & Magnetism, Korea Res. Inst. of Standards and Sci.

Large magneto-conductance effect induced by resistive state switching has received considerable attention due to their interesting physical phenomenon and potential applications to nonvolatile memories, sensors and magneto-logic electronics. Recently, new type of transistor has been proposed in which electric switching function is manipulated by magnetism instead of electricity. We investigated magneto-transport in InAs nanowire by the use of experimental and theoretical method. Some InSb film samples were also tested to support theoretical analysis of the nanowire sample. The characteristic feature of our devices comes from magnetic field dependent carrier generation and recombination in non-magnetic semiconductor materials. These devices show abrupt increase in electrical current as the magnitude of magnetic field decreases. Our device exhibited more than four orders of magneto-conductance change for InAs nanowire. The huge difference in current values near the threshold magnetic field in the present device gives a large ON/OFF ratio and works as an electrical switching device. This nanomaterial device can be a good candidate as an electrical switching device controlled by a magnetic field.

……

SaPo1.20 A Portable Sensor System for Detection of Copper Ions in Water Samples

Yang Li, State Key Lab. of Transducer Tech., Inst. of Electronics, CAS, China
Ye Liu, Zhengzhou Univ. of Sci. and Tech.
Zhiqiang Zhang, Key Lab. of MEMS of the Ministry of Education, Southeast Univ.
Jianhua Tong, State Key Lab. of Transducer Tech., Inst. of Electronics, CAS, China
Chao Bian, State Key Lab. of Transducer Tech., Inst. of Electronics, CAS, China
Hanpeng Dong, State Key Lab. of Transducer Tech., Inst. of Electronics, CAS, China
Shanhong Xia, State Key Lab. of Transducer Tech., Inst. of Electronics, CAS, China

Based on anodic stripping voltammetric method, this paper demonstrated a portable sensor system for copper ions detection in water samples. The proposed sensor system is composed of a customized electrochemical probe, a detecting circuit module and an application (APP) running on an Android device. The electrochemical probe is based on an environment-friendly three-electrode system configured as a gold working-electrode, a platinum counter-electrode and an Ag/AgCl reference electrode. The detecting circuit module utilizes ARM platform to carry out constant potential control, weak current detection and Bluetooth wireless transmission. The Android application is used to manage the wireless communication between the hardware module and the Android device, and implement data management and graphic display of the testing results. The developed sensor system was verified with both standard copper salt reagents and real water samples. The testing result shows that it performes high sensitivity (0.0075 μA/μgL−1) to Cu2+ within the concentrations ranging from 0 μg/L to 400 μg/L by the square wave voltammetry. The testing results given by the sensor syetem were in good agreement with the data obtained by the standard copper detection method. It can also be used to detect other heavy metal ions such as lead at the same time.

……

SuD1 Micro, Nano, and Molecular Fabrication

Session Chair: Zijian Zheng
11:10 - 12:40, Sunday, April 14 (Room: Thai Boromphimarn 4, 3/F)

SuD1.1 Electrodeposition of Magnetic Alginate-poly-L-lysine Microcapsules for Targeted Drug Delivery

Jinchuan Niu, Dept. of Mech. and Energy Eng., Southern Univ. of Sci. and Tech.
Zeyang Liu, Stem Cell Therapy and Regenerative Medicine Lab, Tsinghua-Berkeley Shenzhen Inst. (TBSI)
Hongyong Zhang, South Univ. of Sci. and Tech. of China
Chengzhi Hu, Dept. of Mech. and Energy Eng., Southern Univ. of Sci. and Tech.

In scenarios of targeted drug delivery, capsular drug micro-carriers need maintain drugs in a stable form to specific sites while avoiding the immunogenic and nonspecific interactions that efficiently clear foreign material from the body. Here, we present a facile method to synthesize magnetic drug micro-carriers by template-assisted electrodeposition of alginate hydrogels on a patterned fluorine doped tin oxide (FTO) glass. The magnetic micro-hydrogel can be manipulated by external magnetic field. Electrodeposition of hydrogel is able to generate alginate gels in controlled shape and thickness. After the electrodeposition of alginate micro-carriers, poly-L-lysine (PLL) was coated on the alginate, with ferrite particles embedded inside the PLL membrane. The magnetic force generated by magnetic manipulation system is large and accurate enough to balance the fluid resistance and control microcapsules in three degrees of freedom. When the microcapsules reach the targeted site, citrate solution was added to dissolve the alginate hydrogel and the encapsulated drugs can be released through PLL membrane to external environment. This magnetically driven hydrogel microcapsules can provide a non-toxically, stable, high precision and high degrees of freedom way to achieve drug controlled release.

……

SuD1.2 Direct Nanoimprint on Optical Fibers

Peipei Jia, Topmembrane Tech. Co., Ltd.
Depeng Kong, CAS

Heike Ebendorff-Heidepriem, The Univ. of Adelaide

Nanoimprinting has been applied on optical fibers to generate various miniaturized optrodes for "Lab-on-Fiber" applications. Here we report a direct nanoimprint technique on optical fibers. It has only one single-step: imprinting optical fiber tips against a mold with nanostructures at elevated temperatures. This new method abandons resist used in previous fiber-imprinting techniques. Hundreds of fibers can be shaped in one procedure within minutes, enabling mass-production. These structures can be transformed into plasmonic crystals after metallization. Their optical properties can be modulated through precise control of the imprint depth. Our nanoimprint technique distributes initial costs of molds over a considerable number of devices with moderate cost, making disposable optical fiber devices feasible.

……

SuD1.3 Characterization of Ionic Liquid-Based Pressure Sensor Fabricated by Grayscale Lithography

Yusuke Tsuji, Kyoto Univ.
Yoshikazu Hirai, Kyoto Univ.
Ken-ichiro Kamei, Kyoto Univ.
Toshiyuki Tsuchiya, Kyoto University
Osamu Tabata, Kyoto Univ.

This paper reports an ionic liquid-based pressure sensor fabricated by three-dimensional (3D) lithography to improve a sensor sensitivity. This sensor enables to cover the physiologically relevant blood pressure range and monitor to sinusoidal wave of pressure within a polydimethylsiloxane (PDMS) microfluidic device. Comparing to the conventional ionic liquid-based pressure sensor, the developed pressure sensor provides a high sensitivity and good dynamic responses for pressure measurement. Therefore, the pressure in the microfluidic device would be adjusted to a desired range by employment of the developed sensor, and that make micro physiological systems (MPS) more functional.

……

SuD1.4 Organophosphonate Functionalization of Al2O3-Coated Nanopores

Quoc Hung Nguyen, Molecular Electronics, Technical Univ. of Munich
Christopher Mandla, Molecular Electronics, Technical Univ. of Munich, Germany
Werner Emer, Molecular Electronics, Technical Univ. of Munich, Germany
Feng Yu, Inst. of Semiconductor Tech., TU Braunschweig, Germany
Andrey Bakin, Inst. of Semiconductor Tech., TU Braunschweig, Germany
Marc Tornow, Molecular Electronics, Technical Univ. of Munich, Germany

We present a novel approach for the functionalization of aluminum oxide (Al2O3) coated solid-state nanopores. Silicon nitride nanopores fabricated by e-beam lithography and reactive ion etching were coated with Al2O3 using atomic layer deposition. Formation of self-assembled monolayers (SAMs) of organophosphonic acids (organophosphonates) at the pore walls was studied for three different precursor molecules, namely 1,10-decyldiphosphonic acid, 4-aminobutylphosphonic acid and 12-mercapto-dodecylphosphonic acid. We show by ionic conductance measurements that the nanopores were successfully functionalized with SAMs, leading to the anticipated reduction in pore diameter, hence pore conductance. Functionalized nanopores allow for specifically tailoring the interaction of pore-translocating biomolecules, e.g., for sensing applications.

……

SuD1.5 Anisotropic Pyrochemical Etching of PTFE by Synchrotron Radiation

Masaya Takeuchi, Univ. of Hyogo
Akinobu Yamaguchi, Univ. of Hyogo
Yuichi Utsumi, Univ. of Hyogo

Polytetrafluoroethylene (PTFE) has attention in the field of Lab-on-a-chip (LOC) and micro total analysis system (μTAS) because it has high heat and chemical resistance compared with other plastic materials. Dry etching by x-ray irradiation with heating is utilized, enabling fabrication of high-aspect-structure. However, the method has characteristics that misalignment of the pattern arises due to thermal expansion of PTFE. In this study, we present here anisotropic pyrochemical etching which is performed by heating PTFE after x-ray irradiation at the room temperature. The processing characteristics of PTFE was investigated. As a result, we demonstrated that this method enables the processing depth of 1 mm. This pyrochemical etching process resolves lateral distortion in the pattern structure by x-ray exposure with heating and improves upon the precision of current microfabrication techniques.

……

SuD2 MEMS/NEMS

Session Chair: Xinge Yu
Session Co-Chair: Aaron Ohta
14:00 - 15:30, Sunday, April 14 (Room: Thai Boromphimarn 4, 3/F)

SuD2.1 The Test Structures to Measure Resistivity and Contact Resistance of Poly-Si for Thermoelectric-Photoelectric Integrated Generator

sen zhang, Southeast Univ.
Xiaoping Liao, Key Lab. of MEMS of the Ministry of Education, Southeast Univ.

We propose the polysilicon/Au contact resistance and polysilicon resistivity test structures, which are designed to analyze the thermoelectric performance of thermoelectric micro-generators, and on the other hand can be used to guide the further optimization and preparation of the device. The contact resistance between Au and poly-silicon of integrated generator is tested using a Kelvin structure, and multiple tests adopted to reduce random errors. A pair of contiguous test electrodes are connected to the cross-over structure using a semiconductor girder, and another pair of test electrodes are connected to the cross-arm using a metal girder. Through the design test method, the resistivity of the test structure is 12.01 mΩ·cm under the processing technology of the integrated generator, and the contact resistance of the test structure is 100.765Ω.

……

SuD2.2 Overcoming Positioning Uncertainty for AFM-based Nanorobots using Spiral Local Scan in Non-vector Space

Zhiyong Sun, IMSE, HKU
Huiyang Yu, The Univ. of Hong Kong
Ning Xi, Univ. of Hong Kong

Atomic force microscopy (AFM) based manipulation technologies have been attractive for decades due to the overwhelming advantages of nanometer spatial resolution, universal working environment, and various mechanical measurement methods. It is noted that though the AFM possesses nanometer imaging resolution, it is hard to achieve nanometer locating precision due to uncertainties, especially the thermal drift which distorts AFM images through relatively long capturing time. Since an AFM image is typically utilized as a reference map for nanomanipulation, the uncertainty induced distorted image will definitely introduce location deviation between the real nano-world and the

captured, which usually leads to low efficiency or even failure of tasks. Therefore, to achieve high accuracy for AFM-based manipulation, the positioning uncertainty should be detected and then overcome. In this study, we present a universal approach to quantitatively measure and overcome nanorobot tip locating uncertainty by developing a featureless spiral local scan strategy together with the non-vector space (NVS) navigation approach. Experimental study reveals that variation of the tip locating uncertainty of AFM fast axis is more significant than that of the slow axis with different scan angles.

……

SuD2.3 Design and Parametric Analysis of the Threshold-Value Judging Mechanism in MEMS Security System

Fufu Wang, the Key Lab. of Space Utilization, Tech. and Eng. Center for space Utilization, CAS, China
Lu Zhang, Key Lab. of Space Utilization, Tech. and Eng. Center for space Utilization
Wenzhong Lou, State Key Lab. of Mechatronics Eng. and Control, Beijing Inst. of Tech.
Dakui Wang, Beijing Inst. of Electronic System Eng.
Long Li, Qian Xuesen Lab. of Space Tech.
Zhihong Qiao, Key Lab. of Space Utilization, Tech. and Eng. Center for space Utilization

In this paper, a MEMS security system has been proposed. The size of the device is 10mm×13mm×0.5mm. The role of the threshold-value judging mechanism is to ensure the safety in handling transportation and storage, and reliable firing with the launch overload. Through establishing the three-dimensional model of the threshold-value judging mechanism, establishing the force and the parameters of the threshold-value judging mechanism, deriving the mathematical model according to the variable cross-section cantilevered beam stress theory, establishing the finite element model by using ANSYS/LS-DYNA and carrying out the centrifugal test. Simulation and test results match theoretical results quite well. Appropriate threshold-value judging mechanism is designed to meet two items, one item is threshold node can reliably release slider when the centrifugal acceleration is more than 30000g (g=10m/s2); the other item is the threshold node can effectively restrict the slider to ensure the safety of the device when primary insurance accident arming in handling transportation.

……

SuPo1 Poster Session 3

Session Chair: Cecil Chen
Session Co-Chair:
15:30 - 16:30, Sunday, April 14 (Room: Pre-function Area, 2/F)

SuPo1.1 Radioisotope and Fluorescence Labeled Anti-Flt1 Peptide as a Multimodal Tumor Imaging Agent Targeting Vascular Endothelial Growth Factor-Receptor 1

Dae-Weung Kim, Dept. of Nuclear Medicine, Wonkwang Univ. School of Medicine
Myoung Hyoun Kim, Dept. of Nuclear Medicine, Wonkwang Univ. School of Medicine
Seul-Gi Kim, Dept. of Nuclear Medicine, Wonkwang Univ. School of Medicine

Purpose: We developed a Tc-99m and fluorescence labeled peptide, Tc-99m TAMRA-GHEG-ECG-GNQWFI to target tumor cells, and evaluated the diagnostic performance as a dual-modality imaging agent for tumor in a murine model. Methods: TAMRA-GHEG-ECG-GNQWFI was synthesized using Fmoc solid-phase peptide synthesis. Radiolabeling of TAMRA-GHEG-ECG-GNQWFI with Tc-99m was done using ligand exchange via tartrate. Binding affinity and in vitro cellular uptake studies were performed. Gamma camera imaging, biodistribution and ex vivo imaging studies were performed in murine models with U87MG tumors. Tumor tissue slides were prepared and analyzed with immunohistochemistry using confocal microscopy. Results: After radiolabeling procedures with Tc-99m, Tc-99m TAMRA-GHEG-ECG-GNQWFI complexes were prepared in high yield (>95%). Confocal microscopy images of U87MG cells incubated with TAMRA-GHEG-ECG-GNQWFI showed strong fluorescence in the cytoplasm. Gamma camera imaging revealed substantial uptake of Tc-99m TAMRA-GHEG-ECG-GNQWFI in tumors. Tumor uptake was effectively blocked by the co-injection of an excess concentration of GNQWFI. Specific uptake of Tc-99m TAMRA-GHEG-ECG-GNQWFI was assessed by biodistribution, ex vivo imaging and immunohistochemistry stain studies. Conclusions: In vivo and in vitro studies revealed substantial and specific uptake of Tc-99m TAMRA-GHEG-ECG-GNQWFI in tumor cells. Tc-99m TAMRA-GHEG-ECG-GNQWFI could be a good candidate dual-modality imaging agent for tumors.

……

SuPo1.2 Palladium Film Hydrogen Sensor Based on Micro Hotplate for Fast Response/Recovery

Qi Liu, Shanghai Jiao Tong Univ.
Zhuoqing Yang, Shanghai Jiao Tong Univ.
Guifu Ding, Shanghai Jiao Tong Univ.

In this paper, we innovatively propose a palladium (Pd) film hydrogen sensor by integrating the Pd sensitive film with the suspended micro hotplate. The working temperature of the sensor is controlled by energizing platinum (Pt) resistance wire of the micro hotplate to obtain fast response/recovery. For the Pd film sensor at room temperature, the response/recovery time are about 6 min/5 min. While at elevated temperature, the phenomenon of rapid resistance reduction appears when it comes into contact with H2. We have researched the reason for this phenomenon and proposed that the sensitive mechanism is the redox reaction of Pd film on the suspended structure. When the working temperature is 400°C, the magnitude of response (S) changes to -3.0% within 10 s for 4000 ppm H2 and reaches to -0.42% within 1.5 s for 200 ppm H2.

……

SuPo1.3 Optimization design method of MEMS-IMU structure under vibration stress

Jiehui Zhuang, Shantou Univ.
Yuxian Liu, National Key Lab. of Sci. and Tech. on Micro/Nano Fabrication Inst. of Microelectronics
Chunhua He, National Key Lab. of Sci. and Tech. on Micro/Nano Fabrication Inst. of Microelectronics
Ruizhe Zhang, Shantou Univ.
Bin Zhou, Shantou Univ.
Xiyun Cheng, Shantou Univ.

In order to accurately evaluate the impact of the IMU structure, the double-degree-of-freedom vibration model of the inertial device is established and deduced. The response displacement and acceleration of inertial devices are maximum when the vibration frequency is close to the natural frequencies of IMU structure and inertial devices. The simulation analysis verifies the consistency of the theoretical derivation. Then the beam-reinforcement theory, the fixed-span-reduction and the support-section-augmentation method are proposed to guide the structural optimization design. The vibration experimental results illustrate that Optimized IMU vibration performance improved by more than twice, compared with the original design.

……

SuPo1.4 The Effect of Sodium Doping on Aluminum Oxide Dielectric for Solution Processed Oxide Thin Film Transistor

Seong Jip Kim, Korea Electronics Tech. Inst.
Churl Seung Lee, Korea Electronics Tech. Inst.
Byungwook Yoo, Korea Electronics Tech. Inst.

The transparent IGZO active channel layer and sodium doped Al2O3 dielectric films were prepared by the sol-gel method using the deep ultra-violet (DUV) annealing. Mobility of IGZO TFT using solution processed sodium doped Al2O3 gate insulator is approximately four times higher than that of IGZO TFT using Al2O3 gate insulator. The mobility enhancement is due to the increase of capacitance from sodium ion. The hysteresis direction of Al2O3 device is clockwise and sodium doped device is counter-clockwise. In this study, we reported the electrical properties, mechanisms of hysteresis of DUV-activated devices.

……

SuPo1.5 Principle Design and Analysis of A Novel Gyroscope Based on Charged Particle's Movement in Steady Uniform Magnetic Field

Xiaoyong Lv, Northeastern Univ.
Sheng Hu, Northeastern Univ.
Xiaopeng Sha, Northeastern Univ.
Peng Shan, Northeastern Univ.

The gyrpscope is the crucial device of inertial navigation system as well as the accelerometer, which has been developed for several decades. The gyroscopes are divided into mechanical gyrsocope, optical gyroscope and micromachined gyroscope in terms of the operational principle and these gyroscopes have been applied in many areas such military weapons, industrial production, consumer electric and so on. However, mechanical gyroscope and optical gyroscope are much expensive and complicated to fabricate and operate, which causes the limitation of applications. Micromachined gyroscope is much cheaper for industrial production and consumer electric, but its accuracy is low and the manufacturing process is complicated. A novel type of gyroscope is proposed employing the motion of charged particle in uniform magnetic field in the paper, which is mainly comprised of electronic emitter, magnetic field provider, electronic detector and timer. Compared to the former, it is simple to fabricate and operate after the electric emitter is designed and fabricated.

……

SuPo1.6 Nanoslit Surface Plasmon Resonance Sensor using Automatic Nanoimprinting Lithography for LMP1 Gene Detection

Yu-Jui Fan, Taipei Medical Univ.
Chih-Zong Deng, Taipei Medical Univ.
Nai-Cheng Hou, National Taiwan Univ.
Ting-Yu Su, Taipei Medical Univ.
Pei-Kuen Wei, Academia Sinica
Horn-Jiunn Sheen, National Taiwan Univ.

In this study, a new method of analyzing the nucleotide sequences of the gene LMP1 by using nanoslit Surface Plasmon Resonance (SPR) sensor has been developed. The nanoslit SPR sensor using by automatic nanoimprinting lithography has been realized, which can be used to detect nucleotide sequences of the gene LMP1 after amplifying through Polymerase chain reaction (PCR). We analyzed the experimental result by measuring the red-shift of the resonant spectrum signals, which is corresponding to the numbers of probe-target DNA conjugation.

……

SuPo1.7 A Silicon Resonant Accelerometer with Vibrating Beam Integrated with Comb Fingers Sensing Structure

ziyang song, peking univeristy
jian cui, peking Univ.
qiancheng zhao, peking Univ.

This paper proposed a silicon resonant accelerometer (SRA) with vibrating beam integrated with comb fingers sensing structure. The combination of vibrating beam and sensing combs enables additional mass normally used in conventional design not being required, which enhances the sensitivity and ability of anti-vibration by increasing the resonant frequency. The modal frequency analysis of accelerometer are performed with COMSOL. The simulation results show a close agreement to the test results of nominal frequency 93038 Hz. The sensitivity of the SRA achieves 223.7 Hz/g with nonlinearity of 5.1‰ over the measurement range of ± 1 g.

……

SuPo1.8 Silicon Nanowire Biosensors with Rapid Response and High Sensitivity for Detection of Sulfonamides

Nan Zhang, North China Univ. of Tech.

Highly responsive silicon nanowire (SiNW) arrays with nanometer-size and high surface-to-volume ratio were fabricated on 200 mm SOI substrate by using a self-aligned double pattering (SADP) process. In order to ensure specific bonding with sulfonamides, the surface of the fabricated SiNW biosensors is functionalized with 3-aminopropyltriethoxysilane (APTES), glutaraldehyde and antibody in sequence. Real-time and lable-free detection of sulfonamides using SiNW biosensors was demonstrated with rapid response and high sensitivity. Compared with the conventional sensing techniques, SiNW biosensor exhibits the merits of CMOS compatible, small size, fast-response and lable-free detection for biochemical molecules.

……

SuPo1.9 Effect of Shared Cavity on Electromechanical Performance of Piezoelectric Based Micro-machined Ultrasonic Transducer Array

Weili Wang, Peking Univ. Shenzhen Graduate School
Yihsiang Chiu, Peking Univ. Shenzhen Graduate School
Dan Gong, Xiamen Univ.
Shenglin Ma, Xiamen Univ.
Wen Lei, Peking Univ. Shenzhen Graduate School
Hungping Lee, Shenzhen J-Metrics Tech. Inc.
Huguang Liu, Shenzhen J-Metrics Tech. Inc.
Yufeng Jin, Peking Univ. Shenzhen Graduate School

In this paper, we present a 2μm-thick aluminum nitride (AlN) based piezoelectric micro-machined ultrasonic transducer (PMUT) array, these PMUTs share one cavity. The Finite Element Model (FEM) method is used to perform various electromechanical performances of the PMUT array, such as resonance frequency, displacement frequency response, electromechanical coupling coefficient and sound pressure output to evaluate the time and frequency domain performance of the PMUT array. The results are verified by an impedance analyzer and hydrophone. The results show that the PMUT's resonance frequencies are from 106kHz to 152 kHz, so it can be used for distance detection. The sound pressure of single PMUT received by a hydrophone is from 0.208Pa to 0.752Pa, and when these PMUTs are simultaneously emitted, the sound pressure is 2.57Pa, which is 3-12 times larger than single PMUT. At a fixed resonant frequency, the sound pressure intensity can be controlled by changing the number of transmitted PMUTs to control the ranging range and accuracy.

……

SuPo1.10 A High-sensitivity, Small-size Resonant Pressure Microsensor Based on Optimized Resonator-diaphragm Structure

Yulan Lu, 1. State Key Lab. of Transducer Tech., Inst. of Electronics, CAS, 2. Univ. of CAS, China
Sen Zhang, 1. State Key Lab. of Transducer Tech., Inst. of Electronics, CAS, China, 2. Univ. of CAS, China
Yadong Li, 1. State Key Lab. of Transducer Tech., Inst. of Electronics, CAS, 2. Univ. of CAS, China
Bo Xie, State Key Lab. of Transducer Tech., Inst. of Electronics, CAS, China.
Deyong Chen, State Key Lab. of Transducer Tech., Inst. of Electronics, CAS, China.
Junbo Wang, State Key Lab. of Transducer Tech., Inst. of Electronics, CAS, China.
Jian Chen, State Key Lab. of Transducer Tech., Inst. of Electronics, CAS, China.

This paper presents a high-sensitivity, small-size resonant pressure microsensor based on optimized resonator-diaphragm structure. The proposed microsensor adopt two double-ended tuning fork resonators using electrostatic excitation/ piezoresistive detection as sensing elements, where the resonant frequencies of the resonators increase and decrease respectively under the pressure applied on the pressure sensitive diaphragm. The developed microsensor was fabricated based on a simplified SOI-MEMS technology. Experimental results indicate that the presented microsensor produces a high differential sensitivity of 110 Hz/kPa, high differential linearity dependent coefficient of 0.999999 and quality factors of 8,000.

……

SuPo1.11 Optimization of suspending beams for mode-matching of (100) single-crystal silicon vibratory ring gyroscope

yunyi shu, Kyoto Univ.
Hirai Yoshikazu, Kyoto Univ.
Toshiyuki Tsuchiya, Kyoto Univ.
Osamu Tabata, Kyoto Univ.

In this paper, we improved the geometrical compensation method which was proposed in our previous work, for mode-matching in (100) single-crystal silicon (SCS) vibratory ring gyroscope (VRG) through optimizing the dimension of suspending beams. After the optimization, the smaller frequency split (Δf) of 9 Hz was confirmed by the FEM simulation (Coventorware). In subsequent experiments, Δf of 128 Hz due to imperfect fabrication was eliminated by electrostatic tuning and mode-matching of two "wineglass" modes was realized.

……

SuPo1.12 Synthesis and Photoluminescence Properties of Red-emitting Gd2MoO6:Eu3+ Nanophosphor

Jin Young Park, Pukyong National Univ.
Jong Won Chung, Pukyong National Univ.
Hyun Kyoung Yang, Pukyong National Univ.

A red-emitting Gd2MoO6:Eu3+ phosphors are synthesized by a solvothermal reaction method for latent fingerprint and anti-counterfeiting application. The structural properties are investigated by the X-ray diffraction analysis and Rietveld refinement analysis. The optical properties are studied by the measurement of diffused reflectance, excitation and emission spectra. The PLE spectra of Gd2MoO6:Eu3+ phosphor exhibits broad absorption band due to the charge transfer bands along with f-f transitions of Eu3+ ions. The PL spectra exhibit an intense red emission due to the 5D0→7F2 transition with the CIE chromaticity coordinates (0.650, 0.349). Latent fingerprints developed using Gd2MoO6:Eu3+ nanophosphors exhibit the high sensitivity, resolution and clear images. Gd2MoO6:Eu3+ nanophosphors with a suitable PVA medium offers the high resolution and transparent security ink for anti-counterfeiting labels. These results indicated that Gd2MoO6:Eu3+ nanophosphors are promising materials for latent fingerprint detection and anti-counterfeiting.

……

SuPo1.13 Reducing the Effect of Parasitic Capacitance on the Micro-capacitive Humidity Sensor

Jihang Liu, Univ. of CAS, China
Lidong Du, State Key Lab. of Transducer Tech., Aerospace Info. Res. Inst., CAS, China
Yichen Pan, Univ. of CAS, China
Yusi Zhu, Univ. of CAS, China
Zhen Fang, State Key Lab. of Transducer Tech., Aerospace Info. Res. Inst., CAS, China
Zhan Zhao, Univ. of CAS, China

It is the most important issue how the effects of parasitic capacitance can be reduced during the development of micro-capacitive humidity sensor systems. For this purposes, in this paper, step-by-step optimizations were carried out through packaging and circuit to achieve a high-precision, high-stability and high-repetition humidity sensor system. In order to facilitate the designation and optimization, a MEMS humidity capacitive sensor and a discrete capacitance detection PCB circuit were designed. Subsequent theoretical modeling and COMSOL simulation of the capacitance detection loop were adopted for detailed analysis. Finally, the different optimized samples were tested for humidity response, different experimental results were compared and discussed. It is proved that the optimized sensor system reduced the influence of parasitic capacitance on humidity detection effectively, the hysteresis error was reduced from 2 %RH to 0.3 % RH, the stability and repeatability were greatly enhanced. This also provides a reference for the integrated design of high precision micro-capacitive humidity sensors.

……

SuPo1.14 Sensitive Detection of Multiple Fluoresence Probes based on Surface-enhanced Raman Scattering (SERS) for MERS-CoV

Hanbi Kim, Samsung Medical Center
Joonki Hwang, SG Medical
Jin Hwa Kim, Samsung Medical Center
Sangyeop Lee, SG Medical
Minhee Kang, Samsung Medical Center

Fluorescence-based real-time PCR process requires expensive specialized equipment and has intrinsic limitations on the number of multiplex capability (typically 3~4) due to their broad emission spectrum. On the other hand, surface-enhanced Raman Scattering (SERS) is a promising method in terms of sensitivity and detection capability of multiple fluorescence dyes. The spectra of the same dye reporter obtained using SERS typically produce spectral peaks with a full width half maximum 10–100 times narrower than the peaks observed using fluorescence. This provides opportunities for multiplex analysis and raises the future potential of both high-throughput and point-of-care clinical applications. In this study, we report multiplex SERS platform by using plasmonic paper substrates for sensitive detection of multiple fluorescence dyes. Plasmonic paper, which contains silver nanodot on three-dimensional cellulose fiber, allows for the scalable quantification and identification of fluorescent dyes over broad concentration ranges. Besides, the biotin-modified probes enable the separation and sensitive detection of multiple fluorescence dyes. The platform will reduce both the number of PCR cycle and analysis time, and be applicable to point-of-care (POC) diagnosis for emerging infectious diseases.

……

SuPo1.15 One kind of wide bandwidth and high radiation efficiency antenna for microwave manipulation of NV color centers

Man Zhao, State Key Lab. for Manufacturing Systems Eng. Xi'an Jiaotong Univ.
Qijing Lin, Collaborative Innovation Center of High-End Manufacturing Equipment Xi'an Jiaotong Univ.
Liangquan Zhu, State Key Lab. for Manufacturing Systems Eng. Xi'an Jiaotong Univ.
Libo Zhao, State Key Lab. for Manufacturing Systems Eng. Xi'an Jiaotong Univ.
Zhuangde Jiang, State Key Lab. for Manufacturing Systems Eng. Xiamen Inst. of Tech.

Nowadays, studies based on quantum effect of nitrogen-vacancy (NV) color centers in diamond have received extensive attention, such as quantum computing, quantum information and quantum precision measurement. In these fields, microwave manipulation is one kind of critical technology in which antenna was used to radiate special magnetic pulse to manipulate the quantum state of NV color centers. In this study, High Frequency Structure Simulator software (HFSS) is used to design microstrip antenna whose resonance frequency is 2.87GHz. Based on simulation and experiment, near field radiation of the sample is optimized to improve its magnetic field. Besides, wide bandwidth and high radiation efficiency is achieved through a sandwich structure. This antenna will be helpful in guiding the development of hybrid quantum devices of NV centers, especially for precision measurement sensing.

……

SuPo1.16 Influence of surface roughness on the adhesion hysteresis of thin film

Qijing Lin, School of Mech. and manufacturing Eng. Xiamen Inst. of Tech.
Qijing Lin, Collaborative Innovation Center of High-End Manufacturing Equipment Xi'an Jiaotong Univ.
Fuzheng Zhang, State Key Lab. for Manufacturing Systems Eng. Xi'an Jiaotong Univ.
Feng Han, Collaborative Innovation Center of High-End Manufacturing Equipment Xi'an Jiaotong Univ.
Man Zhao, State Key Lab. for Manufacturing Systems Eng. Xi'an Jiaotong Univ.
Zhuangde Jiang, Manufacturing Systems Eng. Xiamen Inst. of Tech.

The influence of surface topography on adhesion hysteresis of thin film was studied. The Cu/Ti bilayer thin film was fabricated using dc magnetron sputtering technology and its surface adhesion force was measured using force-displacement curves of AFM. The experiment results show that the unload curve exhibits obvious adhesion hysteresis. The theoretical analysis on the influence of thin film roughness to the adhesion hysteresis was carried out using JKR model. The results show that the load curve and unload curve constitute a closed curve and that the smoother the surface, the more obvious adhesion hysteresis (that is, the rougher the surface, the less obvious adhesion hysteresis).

……

SuPo1.17 Enhanced osteogenesis of human mesenchymal stem cells on single-walled carbon nanotubes

Ki-Taek Lim, Kangwon National Univ.

Human mesenchymal stem cells (hMSCs) have gathered significant attention for tissue engineering because of their ability to differentiate into bone cells, chondrocytes, adipocytes and muscle cells. Single-walled carbon nanotubes (SWCNTs) have considered as a potential material for tissue engineering applications due to its unique properties such as high aspect ratio, excellent electrocatalytic activity, and biocompatibility. Here we have prepared the exfoliated SWCNTs layers through an ultra-sonication process in the acidic medium and evaluated their cytotoxicity using the hMSCc. Improved cell viability, as well as osteogenesis of hMSCs, has observed in the presence of exfoliated SWCNTs. Besides, the higher expression of osteogenic differentiation of specific genes in the presence of exfoliated SWCNTs further confirmed their enhanced osteogenic nature. Therefore, with better cell viability and enhanced osteogenesis from these exfoliated SWCNTs indicated their potential to use as a biomaterial for tissue engineering applications

……

SuPo1.18 Design, Analysis and Simulation of a Novel Capacitive Pressure Microsensor Based on Non-coplanar Comb Electrodes

Zhenyu Liu, Inst. of Electronics, CAS, China
Zhan Zhao, Inst. of Electronics, CAS, China
Lidong Du, Inst. of Electronics, CAS, China Remove user
Zhen Fang, Inst. of Electronics, CAS, China Remove user

This paper presents a novel structure for absolute capacitive pressure sensor which utilizes non-coplanar comb electrodes to reach linearity and sensitivity with a wide dynamic range. High linearity and high sensitivity are important factors in pressure sensors. In this paper, the variation of the overlap areas of comb electrodes is used to reflect the change in capacitance, thereby improving the linearity of the sensor. The comb electrodes are designed in the area with the highest sensitivity of the diaphragm to improve the sensitivity of the sensor. In order to optimize the design, the sensor is theoretically modeled and simulated based on COMSOL software. The results show that the theoretical model results are consistent with the simulation results. The designed pressure sensor has high linearity and sensitivity over a wide pressure range.

……

SuPo1.19 Fabrication Process and Performance Analysis of AlN based Piezoelectric Micromachined Ultrasonic Transducer with a Suspended Structure

Li Wang, Peking Univ. Shenzhen Graduate School
Yihsiang Chiu, Peking Univ. Shenzhen Graduate School
Dan Gong, Xiamen Univ.
Shenglin Ma, Xiamen Univ.
Yang Yang, Peking Univ. Shenzhen Graduate School
Heng Li, Peking Univ. Shenzhen Graduate School
Hungping Lee, Shenzhen J-Metrics Tech. Inc.
Huguang Liu, Shenzhen J-Metrics Tech. Inc.
Yufeng Jin, Peking Univ. Shenzhen Graduate School

This paper presents a novel process flow of AlN based ultrasonic transducer with fully suspended structure and TSV 3D integration. In order to obtain the greater displacement sensitivity and output sound pressure, the suspended structure is proposed, which is achieved by etching sacrificial aluminum trenches and utilizing double-sided DRIE of the silicon substrate. It is capable of greatly reducing tensile stress caused by deflection on the edge of the membrane, thereby improving the performance of PMUT, such as acoustic and electromechanical performance. With the help of FEM and COMSOL, simulation has been conducted and the results show that the suspension structure possesses lower resonant frequency and a larger membrane deflection sensitivity, which means higher penetration and acoustic energy. A PMUT with the suspension structure is fabricated. Its impedance diagram is obtained by using impedance analyzer. The resonance frequency of the transducer is 66.35 kHz, and the sound pressure value measured by a hydrophone is 0.453 Pa.

……

SuPo1.20 Copper Oxide Nanorods Electrodes For Organophosphate Pesticide Sensor

Jidapa Chongsuebsirikul, International School of Eng. (ISE), Faculty of

Eng., Chulalongkorn Univ.
Phichamon Sakdarat, International School of Eng. (ISE), Faculty of Eng., Chulalongkorn Univ.
Angkana Phongphut, Dept. of Chemical Eng., Faculty of Eng., Chulalongkorn Univ.
Yoottapong Klinthingchai, Dept. of Chemical Eng., Faculty of Eng., Chulalongkorn Univ.
Seeroong Prichanont, Dept. of Chemical Eng., Faculty of Eng., Chulalongkorn Univ.
Chanchana Thanachayanont, National Metal and Materials Tech. Center (MTEC), National Sci. and Tech. Development Agency
Porpin Pungetmongkol, International School of Eng. (ISE), Faculty of Eng., Chulalongkorn Univ.

Enzymatic pesticide sensor has long been used owing to its high selectivity and sensitivity; however, a number of limi- tations has prevented it from commercialization and portability. In this work, non-enzymatic sensor based on nanomaterial was proposed as an alternative to overcome the limits of enzyme based sensor. Copper oxide nanorods was synthesized by direct anodization and annealing techniques which require less prepa- ration and low cost. The CuO NR arrays electrode was applied in electrochemical analysis of organophosphates pesticide. Our sensor exhibits high sensitivity of 1.227 A/(mol/L) and desirable detection limit of 2 ng/mL, indicating the feasibility of our sensor platform which possesses higher stability, ease of usage, and more cost effective in comparison with the conventional enzymatic pesticide sensor.

……

SuPo1.21 Numerical simulation of photothermally induced Marangoni flow around a microbubble

Ahmed Darwish, Mech. Eng. Dept., Assiut Univ.
Mohamed Abdelgawad, American Univ. of Sharjah

We numerically investigated Marangoni flow induced around a microbubble generated using a laser beam to be used as a method for enhanced fluid mixing on the microscale. We report the generated flow field at different laser powers and different positions of the laser spot relative to the bubble center. We found that flow velocities as high as 47 cm/sec are achievable when the laser spot is closest to the bubble center at a power of 1 mW. This flow velocity increases with increasing the laser power and decreases as the laser spot moves away from the bubble. Our numerical results are validated by comparing it to previously reported experimental results and shows good qualitative agreement. The results reported here indicate that photothermally induced Marangoni flow can be used as an effective mixing mechanism on the microscale.

……

SuPo1.22 Surface grafted core-shell chitosan-modified solid lipid nanoparticles: characterization and application in hydrophobic drug delivery

Mukta Singh, Indian Inst. of Tech. Roorkee, Roorkee
Rutusmita Mishra, Indian Inst. of Tech. Roorkee
Swati Dubey, Indian Inst. of Tech. Roorkee
Partha Roy, Indian Inst. of Tech. Roorkee
R P Singh, Indian Inst. of Tech. Roorkee

Hybrid nanoparticles combining the core of a solid lipid nanoparticle (SLN) system and chitosan (CS) shell were developed for the delivery of hydrophobic curcumin (cur). The curcumin loaded CS-SLNs nanoparticles were formulated by an amalgamation of double-emulsion evaporation and ionic gelation technique for stronger linkage between CS and SLN. The unmodified SLNs and surface modified core-shell CS-SLNs were characterized and compared for particle size, morphology, surface chemistry, and drug release. The CS-SLNs were found to be spherical nano-sized particles with the SLN core acting as a drug depot and outer chitosan shell providing stability and the controlled release of curcumin. Potential application in cancer drug delivery was evaluated by determination of in vitro cytotoxicity and apoptotic effect of encapsulated curcumin on MCF-7 cells. The results suggest that the prepared core-shell nanoparticles are promising delivery systems for poorly soluble drugs with low bioavailability.

……

SuPo1.23 AFM Nanomanipulation with Tip Morphology Estimation and Positioning Compensation

Jing Hou, Shenyang Jianzhu Univ. & Northeastern Univ.
Wu Chengdong, Info. Sci. & Eng., Northeastern Univ.
Zhidong Wang, Chiba Inst. of Tech.
Shuai Yuan, Faculty of Info. & Control Eng., Shenyang Jianzhu Univ.
Peng Yu, Shenyang Inst. of Tech., CAS, China
Liu Tao, Shenyang Inst. of Sci. and Tech.

During the AFM nanomanipulation, the uncertainty of AFM tip morphology and its location seriously affect the reliability of the nanomanipulation results. In response to this problem, we first estimate the tip morphology and reconstruct the scanned image. Based on this, the position and orientation of the interaction between AFM tip morphology and nanoparticle morphology are calculated. The simulation results show that the effect of the tip on the nanoparticle depends on the angle θ between the direction of the tip's pushing direction and its actual force. The smaller the angle θ is, the more effective the distance is. Due to the uncertainty of the position of the tip, the minimum angle θ can't be guaranteed, resulting in unstable results. Therefore, this study refers to the macro robot positioning strategy, using local scanning method to improve the positioning accuracy of the tip relative to the nanoparticles. According to the table of the tip pushing position and the deviation angle θ, the tip pushing position is compensated, which ensures that the deviation angle θ is minimum. Finally, the experimental results of constructing nanostructures verify the effectiveness of the proposed method. This is of great importance to the application of AFM nanomanipulation in Mems / Nems device assembly.

……

SuPo1.24 Thermal Effect of PMUT and Its Application to the Heat Dissipation of Power Electronics

Nan Li, Peking Univ. Shenzhen Graduate School
Yihsiang Chiu, Peking Univ. Shenzhen Graduate School
Dan Gong, Xiamen Univ.
Shenglin Ma, Xiamen Univ.
Yunheng Sun, Peking Univ. Shenzhen Graduate School
Tingyu Li, Peking Univ. Shenzhen Graduate School
Hungping Lee, Shenzhen J-Metrics Tech. Inc.
Huguang Liu, Shenzhen J-Metrics Tech. Inc.
Yufeng Jin, Peking Univ. Shenzhen Graduate School

This paper presents the thermal effect of piezoelectric micromachined ultrasonic transducer (PMUT) and expects to apply it to heat dissipation of power electronics. Experiment results have shown that resonant frequency of PMUT does not change much with different external heat flow disturbance (400μm: 2.28kHz for 150°C temperature difference; 2500μm: 8.82kHz for 150°C temperature difference). Therefore, when a voltage with a certain frequency is applied to the PMUT, it will resonate and form a determined distribution of acoustic streaming on the surface, which enhances heat transfer from the heat source to the adjacent air. Simulation and experiment results have shown that the longer the side length of PMUT, the smaller the frequency of it. Further, as the resonant frequency increases, the maximum acoustic streaming velocity also increases. It has been confirmed by experiment that the PMUT has a cooling effect, which varies with the input power.

……

Author Index

Index of Authors

- L -

- U -

- V -

- W -

- X -

- Y -

- Z -

NEMS 2019

Bangkok, Thailand

IEEE