The 8th Annual IEEE International Conference on

Nano/Micro Engineered and Molecular Systems

IEEE NEMS2013

Program

April 7-10, 2013

Suzhou China

Organizers & Sponsors

Institute of Electrical and Electronics Engineers

Chinese International NEMS Society

IEEE Nanotechnology Council

National Natural Science Foundation of China (NSFC)

Science and Technology on Micro/Nanofabrication Laboratory

Peking University

City University of Hongkong

Soochow University

Nanopolis Suzhou

Science and Technology on Microsystem Laboratory

Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences

CHINANO

Suzhou Institute of Nano-Tech and Nano-Bionics(SINANO), Chinese Academy of Sciences

Suzhou Industrial Park (SIP)

University of California, Los Angeles,(UCLA), USA

MEMS Journal Inc.

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Important Information

Registration

Day0: Sunday, April 7…… 14:30-19:30
Day1: Monday, April 8 …… 8:30-18:00
Day2: Tuesday, April 9 …… 8:30-18:00

Name Badges

All attendees must wear their name badges at all times to gain admission to all conference sessions, exhibitions, receptions and other conference events.

Downloading and Turn in the Slides

For technical reasons, **it is not possible to use your own computer for Oral Presentation**. Laptop (PC with Microsoft Windows), a laser pointer and microphone will be provided. You **MUST COPY your presentation PPT to Conference PC at the Secretary Room (M1) at least 4 hours before your presentation.**

The following points are very important:

- Your PPT file should be submitted according to the session it belongs to. Every file collection desk has a sign with session numbers at **Secretary Room (M1)**. Please be sure to submit your presentation at the right collection desk with your session number.
- Please name your PPT file as your **Paper Number (Paper ID).ppt**, such as 1C2-1(356).ppt, and be sure your PPT file is of **Microsoft Office 2003 or 2007 Version**. Please leave us your name and contact method (e.g. hotel room number). If your file can not work well, we will contact with you.
- If the videos imbedded in your PPT file can not be worked, please convert the **videos format (such as .avi, .mpg, .RMVB) into .WMV format.**

Meeting Room Protocol

Every effort will be made to ensure that all sessions start and end on time. Speakers and attendees are asked to work together to achieve this. This may mean having to cut short a valuable discussion; however, conference organizers request your cooperation for the benefit of all attendees.

Journal Publication

For accepted abstracts, the full paper will be recommended to be published in Nanobiotechnology, Micro & Nano Letters and Journal of Applied Science and Engineering after the conference. All submissions will be subject to the journal's regular peer-review procedures. For more details, please click their websites.

- IET Nanobiotechnology : SCI, 5-year Impact Factor - 2.3
- IET Micro & Nano Letters : SCI, 5-year Impact Factor - 1.06
- Journal of Applied Science and Engineering : EI

Internet Service

There will be free wireless internet service provided by the Conference. The account is "**worldhotel**", **no Password**.

Welcome Message

To the Participants of the 8th IEEE-NEMS conference,

Welcome to "Paradise on Earth" ---- Suzhou! Built in 514 BC, Suzhou is an ancient city with 2500 years' history, located in the center of Yangtze Delta. It is renowned for the classic gardens, canals, silks, lakes, operas, legends and museums. In recently 20 years' fast-growing, Suzhou is changing her ancient face to a modern city and high-tech harbor, its GPD ranks Top 5 in the cities of mainland China. Suzhou Industry Park (SIP) is becoming the new paradise of High-Tech industries, attracts 30% of the Top 500 industries to set up base and over 14000 innovation companies from all over the world. That's why we chose Suzhou to host The 2013 **IEEE International Conference on Nano/Micro Engineered and Molecular Systems** (**IEEE-NEMS 2013**) from April 7-10, 2013.

IEEE NEMS conference is focused on progress in Micro-Nano-Molecular fields, will bring together leading scholars and researchers world-wide to disseminate their most recent and advanced findings in relative areas. Based on great efforts from all committee, IEEE-NEMS 2013 has received more than 500 submissions from over 30 countries and regions worldwide. Of these, we will arrange a 3 days program with 3 Plenary speech, 12 keynote speech, 33 invited speech, 100 oral presentation and 203 posters. Also about 10 exhibitors will show their new production in our conference. We offer all of you 3 gifts in these 3 exciting day,

1、 Top Plenary & Invited Speakers worldwide

2、 Frontier of Micro-Nano Science & Technologies

3、 Platform of Academy & Commercialization & Friendship

We would like to thank all participants of this conference for supporting the IEEE-NEMS conference series and for becoming a part of this fast-growing high-tech community. In particular, we extend our thanks to the Technical Program Committee members, who helped to review a large number of papers and finalized the program and best paper candidates. Not only TPC, all of you, in technical, organizing, sponsoring or consulting, are the key factors to make this conference successful. **Thank all of you!**

Finally, we hope you enjoy the IEEE-NEMS 2013 and your stay in Suzhou!

General Chair: Haixia(Alice) Zhang
Peking University, China

Co-Chair: Chang-Jin "CJ" Kim
University of California, Los Angeles (UCLA), U.S.A.

Co-Chair: Lining Sun
SooChow University, China

Program at a Glance

Conference Venue: Dushu Lake Hotel http://www.ieee-nems2013.org

Day0: Sunday, April 7, 2013

14:30-19:00	**Registration (Till April 9th 6pm in Registration Desk)**
18:00-20:00	**Welcome Reception**
20:00-21:30	**IEEE-NEMS Organizers and Speakers Dinner Meeting** (by invitation only)

Day1: Monday, April 8, 2013

8:30-8:45	1A1 Opening Ceremony (Watson Auditorium) Haixia (Alice) Zhang, Lining Sun, Yuelin Wang, Zheng Cui			
8:45-9:30	1A2 Plenary Speaker 1: Dr. Jing Cheng (Watson Auditorium) Chair: Haixia (Alice) Zhang			
9:30-10:30	1A3 Keynote Speaker 1-2: Martin Wegener & Nicholas Xuanlai Fang Chair: Zhihong Li & Osamu Tabata			
10:30-11:00	**Coffee Break and Exhibition**			
11:00-12:00	1A4 Keynote Speaker 3-4: Gilbert C. Walker & Wan-Lin Guo Chair: Gobrecht Jens & Zheng Cui			
12:00-13:00	**Conference Lunch (Grand Ball Room)**			
13:00-14:15	**1B1(Room F1)**	**1C1(Room M2)**	**1D1(Room M3)**	**1E1(Room EIII)**
Topic	Micro/nano Fabrication & Metrology 1	Nanomaterials 1	Cross-Starit Inivted Session 1	Best Conference Paper
Chair &Co-Chair	Xiaojing Zhang & Weizheng Yuan	Wendong Zhang & Qiao Lin	Zewen Liu & Fangang Tseng	Gwobin Lee & Lina Sarro
Paper ID	327, 285, 308, 326, 197	117,152,297,314,338	136,138,151,367	268,162,243,467,462
14:15-15:30	**1B2(Room F1)**	**1C2(Romm M2)**	**1D2(Romm M3)**	**1E2(Room EIII)**
Topic	Micro/nano Fabrication & Metrology 2	Nanomaterials 2	Cross-Starit Inivted Session 2	Best Student Paper
Chair &Co-Chair	Xiongying Ye & Slaughter Gymama	Wengang Wu & Chengkuo Lee	Chao-Min Cheng & Baoqin Chen	Gwobin Lee & Shanhong Xia
Paper ID	375, 341, 365, 336,504	356,439,478,491,497,544	273,307,298,392	281,283,351,453,165

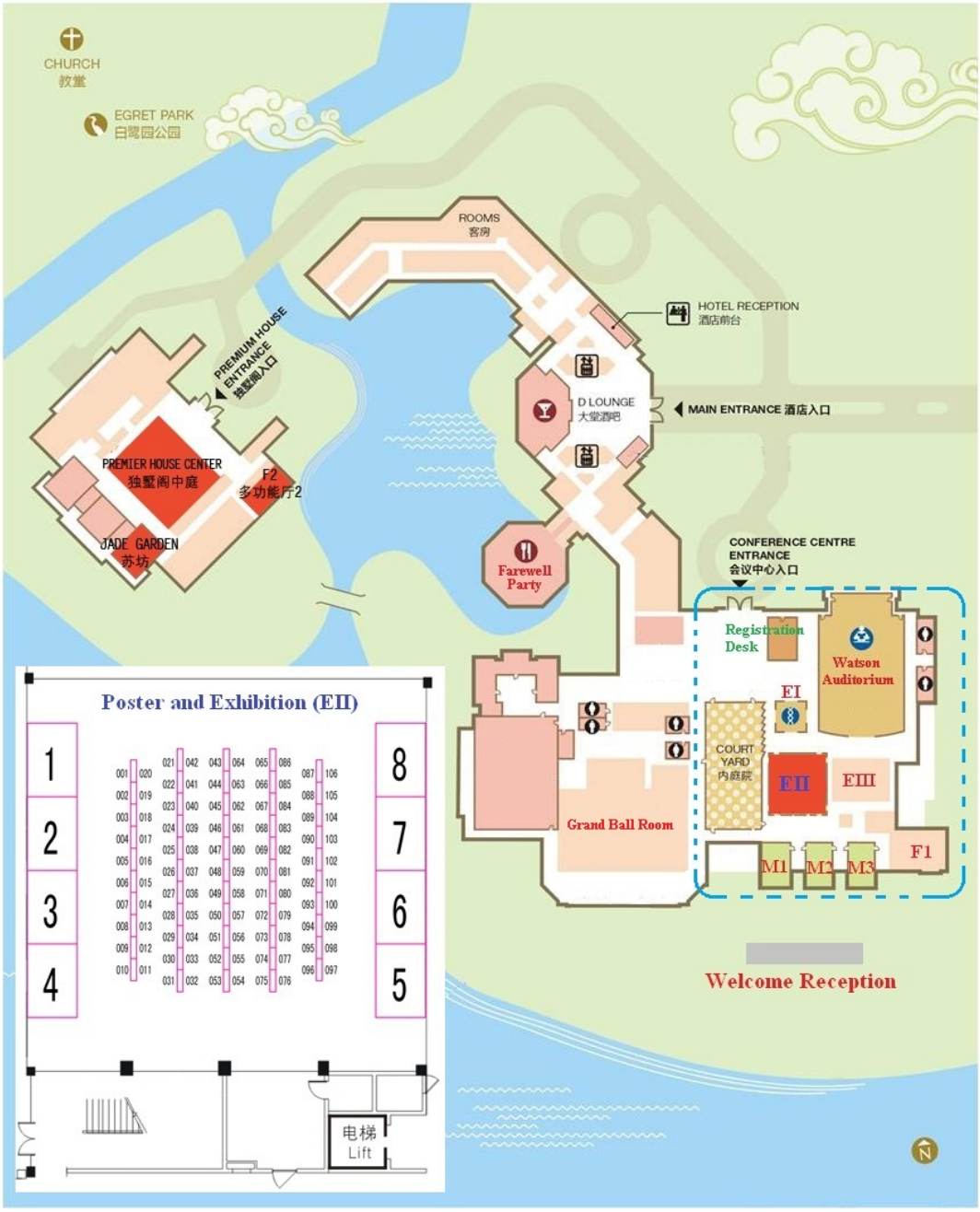
15:30-15:45	Coffee Break and Exhibition			
15:45-17:00	1B3(Romm F1)	1C3(Room M2)	1D3(Room M3)	1E3(Room EIII)
Topic	Micro/nano Fabrication & Metrology 3	Carbon Nanotube & Graphen-based-Device	Cross-Starit Inivted Session 3	CM Ho Microfluidics Award
Chair &Co-Chair	Joan Bausells & Shiyuan Liu	Jianning Ding & Bo Cui	Rong Zhu & Shikang Fan	Chihming Ho & Gwobin Lee
Paper ID	391,438,450,488,500,519	334,490,496,264,399,460	276,458,373,352	517,529,108,196,109
17:00-19:00	Poster and Exhibition 1 (1P, Room EII): Poster Number 1P1-1P100			

Day2: Tuesday, April 9, 2013

8:30-9:15	2A1 Plenary Speaker 1: Dr. Albert ("Al") P. Pisano (Watson Auditorium) Chair: Zhaoying Zhou			
9:15-10:15	2A2 Keynote Speaker 5-6: David R. S. Cumming & Isao Shimoyama Chair: Tie Li & Juergen Brugger			
10:15-10:45	Coffee Break and Exhibition			
10:45-11:45	2A3 Keynote Speaker 7-8: Mark G. Allen & Hongbo Sun Chair: Hans Zappe & Yao-Joe Yang			
11:45-13:00	Conference Lunch (Grand Ball Room)			
13:00-15:00	Poster and Exhibition 2 (2P, Room EII): Poster Number 2P1-2P103			
15:00-16:30	2B1(Room F1)	2C1(Room M2)	2D1(Room M3)	2E1(Room EIII)
Topic	Micro/nano Sensors, Actuators & Systems 1	Nanobiology, Nano-bio-informatics 1	Cross-Starit Inivted Session 4	Flexible MEMS, Sensors & Printed Electronics 1
Chair &Co-Chair	Kean Aw & Qiangbin Wang	Yu-Cheng Lin & Yi-Kuen Lee	Linsen Chen & Lungjie Yang	Haixiong Ge & Tingrui Pan
Paper ID	407,447,455,481,489,503,515	116,120,429,486,551,442,510	556,107,88,90,411	40(IS-1), 502, 131,143,258
16:30-18:00	2B2(Room F1)	2C2(Room M2)	2D2(Room M3)	2E2(Room EIII)
Topic	Micro/nano Sensors, Actuators & Systems 2	Micro/Nano Heat Transfer & Energy Harvesters	Cross-Starit Inivted Session 5	Micro/nanofluidics &Bio Chips 1
Chair &Co-Chair	Wibool Piyawattanametha & Tianling Ren	Lishuang Feng & Chenyang Xue	Yu-Lin Wang & Daoheng Sun	Tza-Huei Wang & Yanyi Huang
Paper ID	127,184,198,256,275,305	443,325,330,339,421,424	557,463,555,546	50(IS-2),110,147,167,246,252

18:30-21:00	**Banquet (Grand Ball Room)**			
Day3: Wednesday, April 10, 2013				
8:30-9:15	3A1 Plenary Speaker 3: Prof. Zhonglin Wang (Watson Auditorium) Chair: Ning Xi			
9:15-10:15	3A2 Keynote Speaker 9-10: Taesong Kim & Gwobin Lee Chair: Wen J. Li & Kukjin Chun			
10:15-10:45	Coffee Break and Exhibition			
10:45-11:45	3A3 Keynote Speaker 11-12: Xinxin Li & Jianxin Wu Chair: Fangang Tseng & Lining Sun			
11:45-13:00	Conference Lunch (Grand Ball Room)			
13:00-14:30	3B1(Room F1)	3C1(Room M2)	3D1(Room M3)	3E1(Room EIII)
Topic	Nanomedicine	Nanobiology, Nano-bio-informatics 2	Cross-Starit Inivted Session 6	Micro/nanofluidics&Bio Chips 2
Chair &Co-Chair	Litao Sun & Wen Li	Xianting Ding & Che-Hsin Lin	Yenwen Lu & Wenhao Huang	Ting Zhang & Junbo Wang
Paper ID	548(IS-3),370,190,319	148,369,474,507,401	176,245,182,435,194	204(IS-4), 277,294,332,387
14:30-15:30	3B2(Room F1)	3C2(Room M2)	3D2(Room M3)	3E2(Room EIII)
Topic	Micro/nano Sensors, Actuators & Systems 3	Integration & Applicationof M/NEMS	Cross-Starit Inivted Session 7	Flexible MEMS, Sensors and Printed Electronics 2
Chair &Co-Chair	Wenjiang Shen & Dongfang Wang	Lianqing Liu & Haidong Liu	Da-Jeng Yao & Wei Wang	Dong Sun & ChengHsin Chuang
Paper ID	322,324,381,393	186,200,345,362,390	340,402,550	466,371,300,280,501
15:45-17:30	Technical Tour			
18:00-20:00	Farewell Party			

Venue Floor Plan



Technical Program Index

In the Technical Program, each paper has a unique number before the title, which clearly indicates when and where the paper is presented.

Typical Oral Paper Number: 1C1-1

- The first number (i.e., 1) indicates the presentation day of the conference:
  1 = Day1(Monday) 2 = Day2(Tuesday) 3= Day3(Wednesday)
- The second letter (i.e., C) indicates what session is being presented.
  Session A Room: Watson Auditorium;
  Session B Room: F1;
  Session C Room: M2;
  Session D Room: M3;
  Session E Room: EIII
- The third number(i.e.,1) shows what period of the paper will be. There are three periods in Day1, two periods in Day2 and Day3.
- The number after the short line (-) shows the number of the paper in the session in sequence starting at 1.

Typical Poster Paper Number: 1P-013

- The first number (i.e., 1) indicates the presentation day of the conference:
  1 = Day1 (Monday) 2 = Day2 (Tuesday)
- The second letter (i.e., P) indicates what session is being presented, i.e., Poster and Exhibition session.
- The number after the short line (-) shows the number of the paper in the session in sequence starting at 1.

To assist you with finding the paper in the Technical Program, we have provided the Paper ID (such as 120, 148) following each paper title.

Abbreviation & Presentation Time

Inivted Speakers: PS- Plenary Speaker(45min); KS- Keynote Speaker(30min);
IS-Invited Speaker(20min); CS- Cross-Starit Inivted Speaker(20min) .

Oral Presentations: Best Conference / Student Paper/CM Ho Award: 15min; Other Oral presentation: 12min.
Author: Copy Presentation PPT to conference computer 4hours before your session in Secretary Room (M1).

Posters: Poster Size: 90cm(width)*120cm(height), every poster should be showed by numbers on time:
Day1 Poster(1P1-1P100)：17:00-19:00 (**Author: Put poster on before 17pm, and remove after 19pm**).
Day2 Poster(2P1-2P103)：13:00-15:00 (**Author: Put poster on before 13pm, and remove after 15pm**).

Conference Committee

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Jia Wei, Delft Univ. of Technology, Holland
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Philip Feng, Case Western Reserve Univ., USA
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Jianmin Miao, Nanyang Tech. Univ., Singapore
Qiangbin Wang, Suzhou Inst. of Nanotech, China
Yi-Kuen Lee, Hong Kong Univ. of Sci. & Tech., HK
Yung-Chun Lee, National Cheng Kung Univ., Taiwan
Mehran Mehregany, CASE Western Reserve Univ., USA
Yuji Miyahara, Tokyo Medical and Dental University, Japan
Weizheng Yuan, Northwest Univ. of Polytechnic Tech., China
Keisuke Morishima, Tokyo Univ. of Agriculture and Tech., Japan
Guus Rijnders, University of Twente, Holland
Kahp-Yang Suh, Seoul National University, Korea
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Hongbo Sun, Jilin University, China
Helmut Seidel, Sarrland University, Germany
Wenjiang Shen, Suzhou Institute of Nanotech, CAS, China
Jeff Wang, Johns Hopkins University, USA
Fan-Gang Tseng, National TsingHua Univ., Taiwan
Pak Kin Wong, University of Arizona, USA
Wei Wang, Peking University, China
Piyawattanametha Wibool, Thailand
Wouter van der Wijngaart, Sweden
Huikai Xie, Univ. Florida, USA
Xiongying Ye, Tsinghua University, China
Hirai Yoshikazu, Kyoto University, Japan
Kwang-Seok Yun, Sogang University, Korea
Darrin Young, Utah, USA
Edward Chow, UC San Francisco, USA
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Gullo Maurizio, EPFL, Switzerland
Veronica Savu, EPFL, Switzerland
Zuankai Wang, City Univ. of Hong Kong, HK

Conference Awards

Best Paper Award

IEEE-NEMS 2013 conference has the following four categories of conference awards:

1. ***Best Conference Paper Award***
2. ***Best Student Paper Award***
3. ***CM HO Best Paper Award in Micro/Nano Fluidics***
4. ***Best Conference Poster Award***

For any of these awards, factors to be considered in determining the winners are the significance of the new findings, applications, technical merits, originality, potential impact on the field, and clarity of presentation. The awards winners will be announced at the **Conference Banquet** and receive a **Certificate** and **Cash Prize of US$ 300**.

IEEE-NEMS 2013 Award Rules

- Authors may nominate their original research work to enter the Awards Competition when they submit their 2-page abstracts. The TPC members nominate the Best Paper Candidates in their review process and Best Paper Committee will decide the final list based on TPC nomination.
- The Technical Program Co-Chairs who are responsible for handling the reviews of abstracts submitted to the "Microfluidics and Nanofluidics" category will nominate finalist papers to be considered for the CM HO Best Paper in Micro/Nano Fluidics Award. Authors who are currently performing research in any labs/organizations directed by Prof. Chih-Ming HO is NOT eligible to receive this award.

Best-Paper-Award Criteria

All the Award Committee Members are the judges for selecting the winner of the Best Paper Award, and they will attend each presentation and evaluate each finalist's performance according to the following evaluation criteria:

(1) Originality, Technical strength and Presentation on the paper;

(2) Oral/Poster presentation and Q&A performance at the conference.

(3) The oral/poster presentations of the finalist papers will be opened to all conference attendees.

Invited Speakers

• Plenary Speakers

Jing Cheng

Jing Cheng, PhD, is a Cheung Kong Professor at Medical Systems Biology Research Center, Department of Biomedical Engineering, Tsinghua University School of Medicine, Director of National Engineering Research Center for Beijing Biochip Technology, Member of the Chinese Academy of Engineering.

Dr. Cheng received his B.Eng. degree in Electrical Engineering from Tongji University (China) and Ph.D. degree in Forensic Sciences from the University of Strathclyde (UK). He gained additional postdoctoral experience at the University of Strathclyde and the University of Aberdeen (UK) and the University of Pennsylvania (USA) where he was appointed as a Research Assistant Professor in the School of Medicine. In 1996 he joined Nanogen Inc in San Diego as a Staff Scientist /Engineer where he was later promoted to Principal Scientist and Engineer, and Principal Investigator. From 1999 to 2001 he assumed the role of Chief Technology Officer at Aviva Biosciences Corp in San Diego, USA. From 2000 to present, he is managing the over-all research as the director of National Engineering Research Center for Beijing Biochip Technology, and serves as CEO and CTO at CapitalBio Corporation in Beijing. He was awarded Nanogen's most prestigious award NanoGrant in 1999, National Young Scientist Award in 2004, Qiushi Outstanding Youth Technology Transfer Award in 2004, Second Prize of the National Awards for Technological Innovation in 2007, Ho Leung Ho Lee Prize for Scientific and Technological Innovation in 2008 and Tanjiazhen Life Science Innovation Award in 2008. Dr. Cheng has published 115 peer-reviewed papers and edited 8 books. In addition, he has obtained 38 European and US patents. He has been an invited speaker to many international conferences. His current interest is in the development of biochip-based microsystems for check-up and diagnostic use and ultra-high throughput systems for drug screening.

Title: Translational Medicine: Microarrays, Microfluidics and Mobile Labs

• Plenary Speakers

Albert ("Al") P. Pisano

Albert ("Al") P. Pisano is a Director of the Berkeley Sensor & Actuator Center (BSAC) and has recently completed 5-1/2 years as Professor and Chair of the Department of Mechanical Engineering at the University of California at Berkeley. He was elected to the National Academy of Engineering in 2001. A member of the American Society of Mechanical Engineers, he was elected to Fellow status in 2004. In Mechanical Engineering, Professor Pisano holds the FANUC Chair of Mechanical Systems, with a joint appointment to the Department of Electrical Engineering and Computer Science. From 1997-1999, he served as Program Manager for the MEMS program at the Defense Advanced Research Projects Agency (DARPA) in Arlington, VA, where he expanded the MEMS research portfolio to 83 contracts awarded nationwide with a total MEMS research expenditure in excess of $168 million distributed over 3 fiscal years. His research interests and activities at UC Berkeley include MEMS for a wide variety of applications, including harsh environment sensors systems.

Title: Harsh Environment MEMS for Energy & Power Applications: Single-Chip, Self-Powered, Wireless Sensor Systems

• Plenary Speakers

Zhonglin Wang

Zhonglin Wang received his PhD from Arizona State University in transmission electron microscopy. He now is the Hightower Chair in Materials Science and Engineering, Regents' Professor, Engineering Distinguished Professor and Director, Center for Nanostructure Characterization, at Georgia Tech. Dr. Wang has made original and innovative contributions to the synthesis, discovery, characterization and understanding of fundamental physical properties of oxide nanobelts and nanowires, as well as applications of nanowires in energy sciences, electronics, optoelectronics and biological science. His discovery and breakthroughs in developing nanogenerators establish the principle and technological road map for harvesting mechanical energy from environment and biological systems for powering a personal electronics. His research on self-powered

nanosystems has inspired the worldwide effort in academia and industry for studying energy for micro-nano-systems, which is now a distinct disciplinary in energy research and future sensor networks. He coined and pioneered the field of piezotronics and piezo-phototronics by introducing piezoelectric potential gated charge transport process in fabricating new electronic and optoelectronic devices. This breakthrough by redesign CMOS transistor has important applications in smart MEMS/NEMS, nanorobotics, human-electronics interface and sensors. Dr. Wang's publications have been cited for over 52,000 times. The H-index of his citations is 110. Dr. Wang was elected as a foreign member of the Chinese Academy of Sciences in 2009, member of European Academy of Sciences in 2002, 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, and fellow of the World Innovation Foundation in 2002. He is an honorable professor of over 10 universities in China and Europe. He received 2012 Edward Orton Memorial Lecture Award from American Ceramic Society, 2011 MRS Medal from the Materials Research Society, 1999 Burton Medal from Microscopy Society of America, 2001 S.T. Li prize for Outstanding Contribution in Nanoscience and Nanotechnology, and the 2009 Purdy Award from American Ceramic Society. Details can be found at:
http://www.nanoscience.gatech.edu

Title: Piezotronics for smart MEMS and human-CMOS interfacing

• Keynote Speakers

Martin Wegener

After completing his PhD in physics in 1987 at Johann Wolfgang Goethe-Universität Frankfurt (Germany), he spent two years as a postdoc at AT&T Bell Laboratories in Holmdel (U.S.A.). From 1990-1995 he was C3-Professor at Universität Dortmund (Germany), since 1995 he is C4-Professor at Universität Karlsruhe (TH). Since 2001 he has a joint appointment at Institut für Nanotechnologie of Forschungszentrum Karlsruhe GmbH. Since 2001 he is also the coordinator of the DFG-Center for Functional Nanostructures (CFN) in Karlsruhe. His research interests comprise ultrafast optics, (extreme) nonlinear optics, near-field optics, photonic crystals, photonic metamaterials, and transformation optics. This research has led to various awards and honors, among

which are the Alfried Krupp von Bohlen und Halbach Research Award 1993, the Baden-Württemberg Teaching Award 1998, the DFG Gottfried Wilhelm Leibniz Award 2000, the European Union René Descartes Prize 2005, the Baden-Württemberg Research Award 2005, and the Carl Zeiss Research Award 2006. He is a member of Leopoldina, the German Academy of Sciences (since 2006), Fellow of the Optical Society of America (since 2008), Fellow of the Hector Foundation (since 2008), and Adjunct Professor at the Optical Sciences Center, Tucson, U.S.A. (since 2009).

Title: Diffraction-unlimited three-dimensional optical lithography

Nicolas Xuanlai Fang

Professor Nicholas X. Fang received his BS and MS in physics from Nanjing University, and his PhD in mechanical engineering from University of California Los Angeles. He arrived at MIT in Jan 2011 as an associate professor in MechE. Prior to MIT, he worked as an assistant professor at the University of Illinois Urbana-Champaign. Professor Fang's areas of research look at nanophotonics and 3D nanomanufacturing. He is an invited participant of the Frontiers of Engineering Conference by National Academies in 2010, a recipient of the ICO prize from the International Commission of Optics (2011), the NSF CAREER Award (2009), the Society of Manufacturing Engineering Outstanding Young Investigator Award (2009); MIT Technology Review Magazine's 35 Young Innovators Award (2008); and the ASME Pi Tau Sigma Gold Medal Award (2006).

Title: Folding Light with Photonic Metamaterials: Controllable Photon Trapping, Extraction and Optofluidic assembly

Gilbert C. Walker

Gilbert C. Walker is the Canada Research Chair Professor of Molecular Microscopy and Nanophotonics in the Department of Chemistry at the University of Toronto. He obtained his A.B. and Ph.D. degrees in Chemistry at Bowdoin College and the University of Minnesota, respectively. His nanoscience research group is known for

developing and applying scanning probe microscopy for the analysis of polymers. Biomaterials are a focus area of his research, with a recent interest in how polymer elasticity affects tissue growth. In a series of papers Walker has shown how the unstable mechanics of AFM tips may be used to measure the adhesive and viscoelastic properties of polymer surfaces. This work began during an effort to characterize anti-fouling polymer surfaces for marine coatings. In addition, Walker's group accomplished the first infrared spectroscopy of polymer surfaces at a spatial resolution below 100 nm.

Title: Novel Developments based on Atomic Force Microscopy

Wan-Lin Guo

Wanlin Guo, Ph.D. Cheng Kong Scholar, Chair Professor in mechanics and nanoscience, founder and director of the Key Laboratory of Intelligent Nano Materials and Devices of the Ministry of Education and the Institute of Nanoscience in Nanjing University of Aeronautics and Astronautics. He has worked on three-dimensional fracture mechanics and life-cycle design of mechanical structures for over 25 years. His research interest since 2000 is focusing on intelligent nano materials and devices, nanotechnology for efficient energy conversion, bio-channels and molecular bionics. He has published more than 300 journal papers on Phys. Rev. Lett., J. Am. Chem. Soc., Nano Lett., Adv. Mater., Phys. Rev. B., Appl. Phys. Lett., ACS Nano., J. Phys. Chem. Lett., J. Mech. Phys. Solids, J. Plasticity, Int. J. Solids Struct. etc. He services as reviewers of more than fifty journals include Account Chem. Res., Phys. Rev. Lett., J. Am. Chem. Soc., Nano Lett., etc.

Title: Advances and Challenges in Graphene Based Devices

David Cumming

David R. S. Cumming has B.Eng (Glasgow, 1989) and PhD (Cambridge, 1993) degrees. He has worked variously on mesoscopic device physics, RF characterization of novel devices, fabrication of diffractive optics for optical and sub-millimeter wave applications and microelectronic design. He is presently Professor of Microsystem Technology and EPSRC Advanced Research Fellow in Electronics and Electrical Engineering at

the University of Glasgow, U.K. where he leads the Microsystem Technology Group.

Title: CMOS Integration for sensing

Isao Shimoyama

Isao Shimoyama received the B.E., M.E, and Dr. of Engineering degrees in mechanical engineering from The University of Tokyo in 1977, 1979, and 1982, respectively. He joined The University of Tokyo in 1982 and is presently Professor, Director of Information and Robot Technology Research Initiative. His current Research interest is in Robotics, MEMS and nano-on -microsystems.

Title: Folding Light with Photonic Metamaterials: Controllable Photon Trapping, Extraction and Optofluidic assembly

Mark Allen

Dr. Mark G. Allen received the B.A. degree in Chemistry, the B.S.E. degree in Chemical Engineering, and the B.S.E. degree in Electrical Engineering from the University of Pennsylvania, and the S.M. and Ph.D. (1989) from the Massachusetts Institute of Technology. In 1989, he joined the faculty of the School of Electrical and Computer Engineering of the Georgia Institute of Technology, where he currently holds the rank of Regents' Professor and the J.M. Pettit Professorship in Microelectronics. His current research interests are in the field of microfabrication and nanofabrication technology, with emphasis on new approaches to fabricate devices with characteristic lengths in the micro- to nanoscale from both silicon and non-silicon materials. Professor Allen was the co-chair of the 1996 IEEE/ASME Microelectromechanical Systems Conference and the 2012 Power MEMS conference. He is also co-founder of two MEMS-oriented companies, CardioMEMS and Axion Biosystems. He is a Fellow of the IEEE.

Title: An Electroplating-Based Approach to Volumetric Nanomanufacturing And Its Application to Energy Conversion and Storage

Hong-Bo Sun

Hong-Bo Sun received the B.S. and the Ph.D. degrees in electronics from Jilin University, Jilin, China, in 1992 and 1996, respectively. He worked as a postdoctoral researcher in Satellite Venture Business Laboratory, the University of Tokushima, Japan, from 1996 to 2000, and then as an assistant professor in Department of Applied Physics, Osaka University, Osaka, Japan. In 2005, he was promoted as a full professor (Changjiang Scholar) in Jilin University, China. His research interests have been laser nanofabrication and ultrafast spectroscopy: Fabrication of various micro-optical, microelectronical, micromechanical, microoptoelectronic, microfluidic components and integrated systems at nanoscales, and exploring ultrafast dynamics of photons, electrons, phonons, and surface plasmons in solar cells, organic light-emitting devices and low-dimensional quantum systems at femtosecond timescale. So far, he has published nearly 150 scientific papers in the above fields, which have been cited nearly 5000 times according to ISI search report.

Title: Nano-micro-engineered polymers for advanced applications

Tae Song Kim

In 1993, Tae Song Kim received the Ph.D degree in department of material science and engineering at Korea Advanced Institute of Science and Technology (KAIST). In 1994, he joined as a senior researcher in Korea Institute of Science and Technology (KIST), and since 2000, he is principal researcher in KIST. He also spent his postdoctoral associate position in department of electrical engineering and computer science at University of Minnesota, USA from 1997 to 1998. He was director of microsystem research center in KIST from 2000 to 2004, and then he served as a director of intelligent microsystem center (IMC) from 1994 to 2010, which was one of the 21st century frontier R&D program sponsored by Ministry of Commerce, Industry & Energy (MOCIE). Since 2005, he is also Professor in department of micro nano system engineering in University of Science and Technology(UST).

Dr. Kim also served as a chairman of MicroTAS 2009 in Jeju, Korea. He is a member of board of director in

Chemical and Biological Microsystem Society (CBMS). He also served as a President of Korea biochip society in 2011 and of Micro Nano systems society in 2012. He received several award: Excellent Research Award from Korea Research Council of Fundamental Science & Technology, Prime minister Award, Excellent Research Award, Chung Jin-Ki Media and Culture Foundation, and Young Engineer Award, The National Academy of Engineering of Korea.

His research interests are MEMS based diagnostic system, BioMEMS, Biosensors/Chip and piezoelectric MEMS devices. He also has research interest in the area of Biomimetic microfabrication.

Title: Molecular based detection using piezoelectric thin film coated microcantilever

Gwo-Bin Vincent Lee

Gwo-Bin Lee received his B.S. and M.S. degrees in Department of Mechanical Engineering from National Taiwan University in 1989 and 1991, respectively. He received his Ph.D. in Mechanical & Aerospace Engineering from University of California, Los Angeles, USA in 1998. Dr. Gwo-Bin Lee was a Distinguished Professor in the Department of Engineering Science at National Cheng Kung University. Currently, he is a Distinguished Professor in the Department of Power Mechanical Engineering at National Tsing Hua University. His research interests are on nano-biotechnology, micro/nanofluidics and their biomedical applications. He is the directors of "MEMS Design and Microfabrication Lab" and "Microfluidics Biochip Lab". Dr. Lee has been active in the field of micro/nanofluidic systems, and is developing integrated micro/nano systems incorporated with nano/biotechnology for biomedical applications. He has developed several micro/nano-scale platforms for cell, protein, and DNA manipulation and detection. Dr. Lee has published over 180 SCI journal papers, 460conference papers, and filed 102 patents (50 patents granted). His works have been highly cited over 3000 times in the past ten years. He has received many important several academic awards. Such as, Excellent Research Award from National Science Council in Taiwan (2007, 2011), National Innovation Award (2008), Distinguished Engineering Professor Award from Chinese Engineering Society (2009), Distinguished Kuo-Ting Lee Researcher Award from Kuo-Ting Lee Foundation (2009).

Title: Optically-induced dielectrophoresis (ODEP) on microfluidic systems for biomedical/nanotechnology applications

Xinxin Li

Prof. Xinxin Li received the B.S. degree in semiconductor physics and devices from Tsinghua University, Beijing, China, in 1987. From 2001 to now, he has been a professor and now serves as the Director of the State Key Lab of Transducer Technology, Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences. He is also serving as Adjunct Professor in both Fudan University and Shanghai Jiaotong University now. Prof. Li was granted the National Science Fund for Distinguished Young Scholar in 2007. He is the laureate of the Chinese National Award for Technological Invention and the Shanghai Award for Technological Invention. He has invented more than 70 patents and published more than 200 papers in referred journals and academic conferences (including about 130 SCI journal papers). He has served as TPC members, respectively, for IEEE MEMS, Transducers and IEEE International Conference on Sensors. He is the editorial board member for Journal of Micromechanics and Microengineering. He has been invited to present invited talks in numerous international conferences and write topic-review papers for international journals.

Title: Efforts on the two interfaces of resonant-cantilever for ultra-sensitive bio/chemical sensing

Jianxin Wu

Mr. Jianxin (Jacky) Wu joined Suzhou Industrial Park Administrative Committee (SIPAC) in 2002 and currently serves as the Deputy Director of Suzhou Industrial Park Sci. & Tech. Development Center and also the Executive Vice President of Suzhou Nanotech Co., Ltd., the General Manager of CHInano Investments Co., Ltd. He has rich experience on investment promotion for WFOE, overseas high-tech experts and companies to establish collaboration and presence in SIP. He and his team have attracted over 100 nanotech companies (including some of the top nanotech companies in SIP such as Halation, Polynova, CUPM, Longpowers, etc.) and 2500 high-tech experts/entrepreneurs to settle in SIP and provided them strategic and comprehensive support/services especially in the industry areas of LED, MEMS, GaN, Laser, Functional Nano Materials, etc.

Title: Suzhou Industry Park Overview and Nanopolis Suzhou

Technical Program

Day1: Monday, April 8, 2013

8:30-8:45 **1A1 Opening Ceremony (Watson Auditorium)**

Haixia (Alice) Zhang, Lining Sun, Yuelin Wang, Zheng Cui

8:45-9:30 **1A2 Plenary Speaker 1: Dr. Jing Cheng (Watson Auditorium)**

Chair: Haixia (Alice) Zhang

(1A2-PS-1) TRANSLATIONAL MEDICINE: MICROARRAYS, MICROFLUIDICS AND MOBILE LABS ……No.1

Jing Cheng

Medical Systems Biology Research Center, Department of Biomedical Engineering, Tsinghua University School of Medicine, Director of National Engineering Research Center for Beijing Biochip Technology, China

With accomplishment of the human genome project, more and more genomic and proteomic information were used for clinical diagnosis. A variety of biochip technology is thereby emerging for massive information analysis and lays the foundation of molecular typing for the coming 3P medicine era. For sample preparation, rapid and effective isolation of cells and molecules from body fluids can be achieved on chip either mechanically or electronically. This is the first step before the following biochemical reactions taking place. For the chip-based amplifications, in addition to the well known thermal cycling amplification technology PCR, there are a variety of distinctive isothermal amplification technologies, such as strand displacement amplification (SDA) and loop-mediated isothermal amplification (LAMP). Among these technologies, some are suitable for DNA testing and some for RNA detection; some are suitable for laboratory analysis and some for field analysis. There are a variety of biological analysis technologies using micro particles as carriers, such as the microbeads encoded with multicolor fluorescence, the micro-columns generated by laser holography, and the micro disks fabricated with optical lithography. All these technologies allow for future analysis with a great flexibility and rich imagination. For separation-based detection technology, there are plenty of methods are available including the high-performance liquid chromatography-chip (HPLC-chip), capillary electrophoresis and chip-time-of-flight mass spectrometry (chip-TOF MS). Additionally, a lot of high-density microarrays have been utilized for the discovery of disease-related biomarkers, including single-nucleotide polymorphism (SNP) array, mutation detection array, array-comparative genomic hybridization, methylation profiling array, mRNA expression array, miRNA microarray, transcription factor array, promoter array, protein array and peptide array, etc. Some low to medium density microarrays have also been developed for individual treatment and applied in clinical laboratories, including the hereditary deafness gene mutation detection chip, mycobacterium tuberculosis drug resistance detection chip, food-borne pathogenic microorganism detection chip and protein chips for autoimmune disease diagnosis. In the future, biochip technology in different forms, from microarray, microfluidic chip to the lab-on-a-chip system, will be more extensively applied in the disease prevention and intervention, individual diagnosis and prognosis.

9:30-10:00 **1A3 Keynote Speaker 1: Martin Wegener (Watson Auditorium)**

Chair: Zhihong Li & Osamu Tabata

(1A3-KS-1) DIFFRACTION-UNLIMITED THREE-DIMENSIONAL OPTICAL LITHOGRAPHY……No.26

M. Wegener

Institute of Applied Physics, Institute of Nanotechnology, DFG-Center for Functional Nanostructures (CFN),Karlsruhe Institute of Technology (KIT), 76128 Karlsruhe, Germany

Electron-beam lithography is a workhorse of nano- and microfabrication. It offers excellent spatial resolution, but it is essentially a two-dimensional technology. For many applications, a truly three-dimensional lithography approach would be highly desirable. Direct laser writing (DLW) optical lithography can be seen as the three-dimensional (3D) counterpart of electron-beam lithography. Over the last decade, 3D-DLW has matured from a laboratory curiosity to a commercially available, reliable, and versatile workhorse (see,*e.g.*,www.nanoscribe.de). However, it seemed as if the Abbe diffraction barrier would fundamentally limit the accessible spatial resolution. Recent work on stimulated-emission-depletion (STED) based 3D-DLW has overcome this barrier. Furthermore, another seemingly fundamental barrier, namely that regarding the accessible overall sample height has also been overcome by introducing 3D "dip-in" DLW, which can potentially be combined with 3D-STED-DLW. In this keynote talk, we give an introduction and review the current state-of-the-art of the field.

10:00-10:30 **1A3 Keynote Speaker 2: Nicholas Xuanlai Fang (Watson Auditorium)**

Chair: Zhihong Li & Osamu Tabata

(1A3-KS-2) FOLDING LIGHT WITH PHOTONIC METAMATERIALS: CONTROLLABLE PHOTON TRAPPING, EXTRACTION AND OPTOFLUIDIC ASSEMBLY ……No.27

Nicholas Xuanlai Fang

Department of Mechanical Engineering, Massachusetts Institute of Technology, USA

Recently, exciting new physics and applications are emerging from metamaterials made of artificial "atoms" and "molecules". These metamaterialshas

inspired a series of key explorations to manipulate, store and control the flow of energy at unprecedented dimensions.Yet, these ground-breaking achievements are only the tip of the iceberg, where the next-generation metamaterials, incorporating unique topological interactions between waves and matter, are waiting to be discovered.In this talk, I will discuss our effort of fabrication and characterization of these optical metamaterials for broadband light trapping, mixing and extraction. Such strong localizationand enhanced photoemission is observed by novel near field optical and electron probes.These novel metamaterials,could be the foundation ofbroadband photo-absorbers, directional emitters, as well as compact and power-efficient devices in highly parallel optical networks.I will also discuss our progress indigital optofluidic self-assembly processes for scalablemanufacturing of these heterogeneous metamaterials.

10:30-11:00 **Coffee Break and Exhibition**

11:00-11:30 **1A4 Keynote Speaker 3: Gilbert C. Walker (Watson Auditorium)**

Chair: Gobrecht Jens & Zheng Cui

(1A4-KS-3) NOVEL DEVELOPMENTS BASED ON ATOMIC FORCE MICROSCOPY ……No.22

Gilbert C. Walker

Department of Chemistry, University of Toronto, Canada

Several developments of atomic force microscopy are reported. The first is a way to probe the mechanical responses of single molecules and the surfaces to which they are attached. The second is a way to probe the mechanical properties of anisotropic nanomaterials such as individual boron nitride nanotubes. The third is a way to probe the infrared vibrational spectra of materials with 20 nm spatial resolution. The physical principles and scientific frontiers opened by these probes will be presented.

11:30-12:00 **1A4 Keynote Speaker 4: Wan-Lin Guo (Watson Auditorium)**

Chair: Gobrecht Jens & Zheng Cui

(1A4-KS-4) ADVANCES AND CHALLENGES IN GRAPHENE BASED DEVICES ……No.29

Wan-Lin Guo

Institute of Nanoscience, Key Laboratory of Intelligent Nano Materials and Devices of Ministry of Education and State Key Laboratory of Mechanics and Control for Mechanical Structures, Nanjing University of Aeronautics and Astronautics, Nanjing, 210016, China

During the last three decades, we have been digging down from macro- to micro- and nano-scale for fabrication of both structures and electromechanical systems. Especially in the last decade, our ability to manipulate and use the single atomic hexagonal carbon layer, graphene, lead us to a new stage in micro and nanotechnology. No like the never visible o-dimensional (0D) nanoparticles and one-dimensional (1D) nanowires and nanotubes, graphene bring us into a fantastic two-dimensional (2D) age of nanotechnology, which can be fabricated and applied at wafer scale, visible at single layer but showing exceptional mechanical, electronic, magnetic and optical properties completely distinguished from its bulk form graphite. This kind of 2D functional materials links the atomic properties with the engineering scale of our mankind, completing the nanomaterial dimensions and showing greater potential for marketing technology. In this lecture, we will briefly review the recent advances in fabrication, characterization, transfer, and applications of single and few layered graphene for functional devices, including strain sensors, gas flow sensors, transistors, photonic manipulators, magnetic devices, electromagnetic and optoelectronic devices, and in energy technology. Other important 2D materials beyond graphene will be briefly introduced. Especially, challenges for manufacture of 2D materials and their devices will be analyzed based on our experience and comprehensive understanding. New materials are always used for create new principle devices and bring us into new regime of technology. Some perspectives for graphene like 2D functional materials will be finally discussed.

12:00-13:00 **Conference Lunch (Grand Ball Room)**

13:00-14:15	**Session:1B1**	**Session:1C1**	**Session:1D1**	**Session:1E1**
Room	**F1**	**M2**	**M3**	**EIII**
Topic	**Micro/nano Fabrication & Metrology 1**	**Nanomaterials 1**	**Cross-Starit Inivted Session 1**	**Best Conference Paper**
Chair &Co-Chair	**Xiaojing Zhang & Weizheng Yuan**	**Wendong Zhang & Qiao Lin**	**Zewen Liu & Fangang Tseng**	**Gwobin Lee & Lina Sarro**
Paper ID	**327, 285, 308, 326, 197**	**117,152,297,314,338**	**136,138,151,367**	**268,162,243,467,462**

13:00-14:15 Session: 1B1 Micro/nano Fabrication & Metrology 1 Room F1

Chair&Co-Chair: Xiaojing Zhang & Weizheng Yuan

(1B1-1) FABRICATION OF THREE-DIMENSIONAL METALLIC MICROCOMPONENTS IN FUSED SILICA BY A FEMTOSECOND LASER & MICROMOULDING (FLM) METHOD ……No.327

Keyin Liu, Yulong Zhao, Qing Yang, Feng Chen, Shengguan He, Xiaole Fan, Lei li, Chao Shan and Hao Bian

State Key Laboratory for Manufacturing System Engineering & Key Laboratory of Photonics Technology for Information of Shaanxi Province, Xi'an Jiaotong University, Xi'an, 710049, China

Three-dimensional (3D) metallic microdevices are essential for the micro-electromechanical systems (MEMS) and microfluidic applications. In this paper, a femtosecond laser based micromoulding (FLM) method is employed to fabricate 3D metallic conductive microcomponents in fused silica. 3D microcavities/ microchannels in fused silica, which are served as the molds of metallic microcomponents, are fabricated by taking full advantage of the improved femtosecond laser irradiation followed by chemical etching (FLICE) technology. Solid metallic conductive microcomponents are then achieved in the 3D micromolds by injecting liquid metal with a microfluidic-compatible micromoulding device and solidifying the liquid metal. The FLM technology consists of a facile and maskless fabricating procedure, and enables convenient application of the inherently aligned 3D metallic microcomponents in microfluidic systems.

(1B1-2) MICRO-RAMAN SPECTROSCOPY ANALYSIS OF RESIDUAL STRESS IN POLYSILICON MEMS RESONATORS ……No.285

Chenxu Zhao, Mengwei Li, Ming Yin, and Zewen Liu

Institute of Microelectronics, Tsinghua University, Beijing, China

This paper presents the recent results of utilization of micro-Raman spectroscopy to measure and characterize residual stress in polysilicon doubly-clamped MEMS resonators with small lateral size. Due to imprecise prediction of the magnitude of intrinsic residual stress, detrimental effect of the residual stress severely shifts the resonant frequency of MEMS resonator from the analytical pre-designed value. The stress is not only determined by the fabrication process but also related to the structural dimensions of resonators. In this work, micro-Raman spectroscopy was used to measure the residual stress of resonators with widths down to 2μm. The results show that the optimized resonator with length shorter than 50μm and width between 3.2μm and 4.1μm exhibits minimum residual stress.

(1B1-3) MICRO/NANO STRUCTURE WRITTEN VIA SHEATH GAS ASSISTED EHD JET ……No.308

Guangqi He, Gaofeng Zheng*, Jianyi Zheng, Yihong Lin, Jin Wei, Haiyan Liu, Bin Wang, Daoheng Sun

Department of Mechanical and Electrical Engineering, Xiamen University, Xiamen, China

Laminar sheath gas is introduced into the Electrohydrodynamic Direct-Write (EDW) to promote the stability of charged jet and deposition precision of printed micro/nano structure. A novel EDW spinneret with sheath gas is designed to fabricate fine 1D micro/nano structure under lower applied voltage. The laminar sheath gas restricts the whipping motion of charged jet as well as decreases the required voltage. With the help of stretch force stems from sheath gas, the initiation voltage and sustaining voltage of EDW can be decreased obviously; the average diameter of micro/nano structure can be decreased from 21.58μm to 505.58nm. Different patterns can be also obtained by adjusting the moving speed of the collector in a sheath gas cases. Therefore, it can be concluded that provides a unique way for the precision deposition and integration of EDW micro/nano structure with in the micro/nanosystems.

(1B1-4) FABRICATION OF SILICA OPAL ARRAY WITH HIGH MECHANICAL STRENGTH ……No.326

Hui Li, Wei Wang, Huaiqiang Yu, Renxin Wang, Zewen Wei, Zhihong Li

National Key Laboratory of Science and Technology on Micro/Nano Fabrication, Institute of Microelectronics, Peking University, Beijing, China

This paper focuses on fabrication of opal structures by self-assembling silica spheres, which can be used as an array of high throughput and low cost reactors or micro-filters. The reactors can carry out hundreds different reactions in parallel; while there is about 50 nano-liter reagent consumed in each reactor. It not only provides large surface area for reaction, but also solves the issue of high throughput experiments. The mechanical strength of the opal has to be high enough to withstand fluid flushing during sample loading and cleaning. In this paper, the optimized process is developed to fabricate the robust and crack-less opal membrane.

(1B1-5) SLIDING MODE CONTROL WITH ADAPTIVE FEEDFORWARD COMPENSATOR FOR ULTRA-PRECISION ACTIVE VIBRATION ISOLATION ……No.197

Huayan Pu [1], Wenchuan Jia[1], Xuedong Chen[2]

[1]*School of Mechatronics Engineering and Automation, Shanghai University, China*

[2]*the State key Laboratory of Digital Manufacturing Equipment & Technology, Huazhong University of Science and Technology*

Ultra-precision active vibration isolation system protects ultra-precision equipment from the transmission of external vibration, and suppresses vibration incurred by internal structures. In order to obtain the ideal skyhook effect, the sliding mode controller with adaptive feedforward compensator is proposed in this paper. With the controller, the vibration system can obtain the desire performance even when the system is under model uncertainties and significant direct disturbance. A series of simulations are carried out to verify the effectiveness of the controller.

13:00-14:15 Session: 1C1 Nanomaterials 1 Room M2

Chair&Co-Chair: Wendong Zhang & Qiao Lin

(1C1-1) Ag_2S QUANTUM DOT: A BRIGHT AND BIOCOMPATIBLE FLUORESCENT NANOPROBE IN THE SECOND NEAR-INFRARED WINDOW ……No.117

Yejun Zhang[1], Yan Zhang[1], Guosong Hong[2], Hongjie Dai[2], Qiangbin Wang[1]
[1]*Suzhou Institute of Nano-Tech and Nano-Bionics, Chinese Academy of Sciences, Suzhou, China.*
[2]*Stanford University, Stanford, United States.*

Fluorescent imaging in the second near-infrared window (NIR-II, 1.0~1.4 μm) is appealing due to minimal autofluorescence and negligible tissue scattering in this region, affording maximal penetration depth for deep tissue imaging with high feature fidelity. Simulations and modeling studies suggested that fluorophores with emission in the 1000-1320 nm NIR-II region could significantly improve signal-to-noise ratio compared to those emitting at 650-950 nm (NIR-I). Recent efforts have been devoted to identifying NIR-II emitting agents for in vivo imaging applications. Quantum dots (QDs) such as PbSe, PbS, and CdHgTe with NIR emission have been successfully developed. However, the highly toxic nature of Pb, Cd and Hg is of concern for in vivo applications. Therefore, highly biocompatible NIR-II fluorescent probes that do not contain Cd, Pd or Hg will facilitate biological imaging in this beneficial spectral region. Herein, we first reported a new type of NIR QDs, Ag2S QDs, with emission in the NIR-II region. For the first time, highly selective in vitro targeting and imaging of different cell lines were achieved using biocompatible NIR-II Ag2S QDs with different targeting ligand. Furthermore, in vivo imaging of early-stage tumor in mice with Ag2S QDs was also achieved. Video-rate dynamic contrast-enhanced imaging revealed deep inner organs and tumor in mice. Due to ultralow background and reduced photon scattering in NIR-II, early-stage detection of ultrasmall tumor (~0.25 mm3) and hindlimb vessel imaging with Ag2S QDs at high spatial resolution and deep tissue penetration were demonstrated. The 6PEG-Ag2S QDs afforded an unusually high tumor uptake of QDs of >10 % injected dose/gram, owing to a long circulation half-life of ~4 h. Clearance of the injected 6PEG-Ag2S QDs occurred mainly through the biliary pathway in mice. The Cd- and Pd-free nature, NIR-II emission, branched PEG coating and favorable pharmacokinetics of 6PEG-Ag2S QDs make them a promising in vivo imaging agent.

(1C1-2) NANOTEXTURED CHITOSAN SURFACES FOR STUDYING CELL BEHAVIORS ……No.152

Chung-Yao Yang, Chun-Yen Sung, J. Andrew Yeh
Institute of Nanoengineering and Microsystems, National Tsing Hua University, Taiwan

This paper describes an easy method to fabricate nanoscale features on chitosan membranes from a silicon mold through using a combination of solution casting and etching process. Three different molecular weight chitosan powders were used to evaluate the topography of nanoscale features after molding process. The Young's modulus of three different molecular weight (120, 185 and 250 kDa) are almost the same in air with a value about 6 GPa and in medium with a value about 5 MPa. The size of the nanotexture is 250 nm in width and 200 nm in depth. Human breast cancer cells MCF-7 and HIG-82 fibroblasts were cultured on patterned nanotextured chitosan surfaces and both cells can be patterned on specific regions. The results exhibited the cells preferred to adhere on flat chitosan surfaces than on nanotextured chitosan surfaces. This nanotextured chitosan surfaces could be used for controlling cell development in bio-relevant applications, such biomedical devices, biology and tissue engineering.

(1C1-3) GROWTH OF ARRAYED ZnO NANOWIRES USING A SOLUTION METHOD ……No.297

Shouhe Zhang[1, 2], Yongji Gao[1, 2], Mengdi Han[1], Haixia Zhang[1]
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In this paper, we report a simple solution method to synthesize well-aligned ZnO nanowires (NWs) arrays on silicon substrate with ZnO seed layer. We can control the morphology of ZnO NWs arrays by adjusting growth parameters, such as the thickness of the seed layer, the concentration of the solution, the growth temperature, the growth time and the pretreatment, etc. The size of ZnO NWs will change regularly according to the these parameters, too, for example, results show that the diameter and alignment will upgrade as the thickness of the seed layers increased, and the length and diameter will increase as the concentration, temperature and growth time increased. What's more, the ultrasonic pretreatment of the solution mixture and the pre-cleaning of the substrate in the reaction solution will enhance the uniformity of ZnO NWs significantly . This synthesis technique can be carried out at low temperature, low cost and large scale on any substrates.

(1C1-4) FABRICATION OF NANOPORES USING ELECTRON BEAM ……No.314

Tao Xu, Xiao Xie, Litao Sun
SEU-FEI Nano-Pico Center, Key Laboratory of MEMS of Ministry of Education, Southeast University, China

Sub-5 nm nanopores are widely used in singlemolecule detections for biological and chemical applications. However, the traditional fabrication methods are difficult to reduce pore size to sub-5 nm. Focused electron beam irradiation inside a transmission electron microscope (TEM) is verified experimentally to be an effectively straightforward way to fabricate such small pores. The fabrication process can be explained by a simple physical collision model. We also fabricate graphene nanopores under various temperatures. The results verify that drilling at high temperature and direct thermal heating treatment can be beneficial to fabricate carbon nanostructure with high crystallization, which will promote the study of biological measurement. High temperature could also modulate the duration of fabrication, which can enhance the size control during nanopore fabrication.

(1C1-5) MECHANICAL PROPERTIES OF PIEZOELECTRIC PVDF/MWCNT FIBERS PREPARED BY FLAT/HOLLOW CYLINDRICAL NEAR-FIELD ELECTROSPINNING PROCESS ……No.338

Z.H. Liu[1], C.T. Pan[1], L.W. Lin[2], H.W. Li[1], C.A. Ke[1], J.C. Huang[3], P.S. Wang[1],
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[3]*Department of Materials and Optoelectronic Science, National Sun Yat-Sen University, Kaohsiung Taiwan*
The existing study focused more on onedimensional nanostructures such as nanotubes and nanofibers for various potential applications, but less on evaluation of their mechanical properties. Therefore, this study mainly concentrates on near-field electrospinning (NFES) and hollow cylindrical near-field electrospining (HCNFES) process to fabricate permanent piezoelectricity of polyvinylidene fluoride (PVDF)/multi-walled carbon nanotube (MWCNT) nanofibers. Comparing NFES and HCNFES, it can be seen that HCNFES was fabricated under high electrical field with in-situ strong mechanical stretching for possible alignment of dipoles along the longitudinal direction of PVDF nanofiber. Therefore, PVDF nanofibers fabricated using HCNFES can be of smaller diameters and higher contents of β-phase with excellent piezoelectricity. In addition, the crystallization and mechanical behaviors of PVDF nanofibers were influenced by the PVDF solution concentration and addition of MWCNT. The tensile test shows that the yield strength increases with increasing 0.03% MWCNT and 16% PVDF solution.

13:00-14:15 Session: 1D1 Cross-Starit Inivted Session 1 Room M3

Chair&Co-Chair: Zewen Liu & Fangang Tseng

(1D1-1) DUAL FACED SERS NANOPARTICLES EQUIPPED WITH TRI-FUNCTIONS FOR TARGET DRUG DELIVERING INTO SINGLE CELL ……No.136

Hsin-Yi Hsieh[1] and Fan-Gang Tseng[1,2,3]
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We report an approach to fabricate dual-faced polystyrene beads (DFPSBs) with tri-functions of tumor cells recognition, drug delivery, and real-time Raman sensing. Onestep oxygen-plasma treatment process was used to etch commercially available fluorescent polystyrene beads into a corrugated upper hemisphere and simultaneously change the entire surface with carboxylic groups. After depositing gold onto the corrugated hemisphere for surface enhanced Raman scattering (SERS) while leaving the other smooth and clean hemisphere for fluorescence detection, the DFPSBs are formed with dual-surfaces of plasmonic gold semishells on the top and fluorescent carboxylated polystyrene at the bottom. Sulfo-NHSSS-biotin disulfide linkers and anti-CD44 antibodies can be modified and added onto the top gold surfaces and the bottom carboxyl groups through Au-S and peptide bonds, respectively. Then, the surface-modified AuFNM suspension can be employed to target overexpressive glycoproteins (CD44) on the surfaces of cancer cells and release their loads *via* the cleavage of disulfide bonds in the cytoplasm environment. These anti-CD44-modified DFPSBs exhibit a 12-fold cancer targeting ability on HeLa cells when compared to a normal chondrocyte cell.

(1D1-2) DEPTH DETECTION FOR FAST MOVING OBJECTS IN A MICROCHANNEL UTILIZING CHROMATIC ABERRATION UNDER A DIASCOPIC MICROSCOPE ……No.138

Shin-Yu Su, Che-Hsin Lin
Department of Mechanical and Electro-mechanical Engineering,National Sun Yat-sen University, Taiwan
This research describes a novel technique for detecting the z-position of fast moving objects utilizing chromatic aberration, with this simple and novel approach, the depth of moving object can be measured without delicate optical system. Instead of complicated calculation, the intensity ratio of 2 defined wavelengths is used to indicate the relationship between depth and the change in wavelength. Results show that the developed system gives a large detection range of 30 μm with a high linearity. The device is capable to resolve variation in depth as low as sample size within 4-5μm when using 20X objective. This developed system is able to resolve the moving particles with the throughput of about 126 particles per second, which is much faster than the speed of a confocal microscope system. The developed depth detection scheme provides a simple and high performance way to dynamically identify the z-position of micro moving parts in MEMS applications.

(1D1-3) MICRO THERMAL FLOW SENSORS/SYSTEMS ON FLEXIBLE PCB AND EXTENSIVE APPLICATIONS ……No.151

Rong Zhu, RuiYi Que, Zhe Cao
State Key Laboratory of Precision Measurement Technology and Instruments, Department of Precision Instruments and Mechanology, Tsinghua University, China
We demonstrate our researches on developing micro thermal flow sensors by depositing nano metallic films on flexible substrates for detecting surface flow. The fabrication of the sensors is incorporating standard printed circuit technique with micromachining deposit/sputter, which takes advantages of low cost, easy fabrication, easy packaging and integrating sensors with processing circuits. The applications using the sensors to detect airflow around air vehicles, underwater wall shear stress, and to measure respiratory flow for monitoring and diagnosing respiratory diseases are also presented.

(1D1-4) NOVEL INERTIAL SWITCHES FOR IMPACT DETECTION ……No.367

Yao-Joe Yang
National Taiwan University, Taipei, Taiwan
This work presents the development of two types of inertial switches for impact detection. The first type of the devices, as shown in Figure 1, uses stimuli-sensitive hydrogel integrated with a passive inductor/capacitor (L-C) resonator, and the detected signal can be interrogated wirelessly using the phase-dip technique. This device consists of a glass substrate with a capacitor plate and an inductor coil, and a PDMS micro-fluidic chip containing a hydrogel composite and water droplet. When the acceleration exceeds the designed threshold-level, the water passes through the channel to the hydrogel cavity. The hydrogel swells and changes the capacitance of the integrated L-C resonator, which in turn changes the resonant frequency that can be remotely detected. The response time of the device can be considerably reduced by introducing multi-wall carbon nanotubes (MWCNTs) into the hydrogel composites. All PDMS structures were fabricated using soft lithography. The L-C resonator was fabricated using a lift-off process to pattern

metal layers on a glass substrate. The dimensions of the device are 15 mm × 10 mm × 1.5 mm. The characterization of the proposed device was also demonstrated. The threshold g-values, which differ for various applications, were strongly affected by the channel widths. The phase-dip measurement shows that the resonant frequencies shift from 164 MHz to approximately 148 MHz when the device is activated by acceleration.

13:00-14:15 Session: 1E1 Best Conference Paper Room EIII

Chair&Co-Chair: Gwobin Lee & Lina Sarro

(1E1-1) SILICON NANOWIRE RESONATORS FOR AEROSOL NANOPARTICLE MASS SENSING ……No.268

Hutomo Suryo Wasisto[1], Stephan Merzsch[1], Andrej Stranz[1], Andreas Waag[1],Erik Uhde[2], Tunga Salthammer[2], Erwin Peiner[1]
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In this work, silicon nanowire-based resonators were fabricated and employed to sense aerosol nanoparticles (NPs) by measuring resonant frequency shifts induced by the mass of stuck NPs. The fabrication of silicon nanowire (SiNW) arrays was performed utilizing inductively coupled plasma (ICP) cryogenic dry etching and multiple thermal oxidations. The SiNWs were coated with gold for contacting to the homebuilt electrostatic NP sampler to collect the flowing NPs. A piezoelectric shear actuator mounted in the frequency measurement system was used to excite the SiNW sensors into resonance. Tested in a TiO_2 aerosol sampling with a total concentration of ~8500 particle/cm^3, the sensor displayed its feasibility as a nanobalance to detect aerosol NPs in the femtogram scale with a mass sensitivity of 7.1 Hz/fg and a mass resolution of 31.6 fg. To extend the operating life of the sensor, an ultrasonic removal method was used to detach the adhered NPs.

(1E1-2) SPECIAL PROPERTIES OF NEW TYPE CARBON-COPPER CORE-SHELL NANOPARTICLES COMPOSITE MATERIAL FABRICATED USING BIOMASS AS TEMPLATE ……No.162

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A new type of carbon-copper core-shell nanoparticles (CCCSNs) have been fabricated using biomass as template. CCCSNs, as made, are homogeneously embedded in carbon black as a composite material. The composite material can be further processed in different dimensions (from hundreds nanometers to meters) based on application needs. The special carbon shells transformed from biomass can protect the copper core from oxidation in ambient environment for years, at the same time; let Cu show the typical antibacterial, antifungal, antifouling properties through it. The CCCSNs made from this innovative technology eliminates the detrimental impacts of conventional engineered nanoparticles usually have and provide the superior properties, including the low cost for fabrication, that conventional copper nanoparticles don't have.

(1E1-3) SPONTANEOUS SHRINKING SILICA NANOMEMBRANE FOR SOLID PHASE DNA EXTRACTION ……No.243

Yi Zhang[1], Ye Zhang[1], Brian Keeley[2], Alejandro Stark[2], Tza-Huei Wang[1, 2]
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In this report, we describe a novel approach to fabricating silica nanomembrane based on the spontaneous shrinking of pre-stretched, heat-shrinkable polyolefin (PO) film coated with silica. The surface resulted from the surface wrinkling exhibits unique overlaying hierarchical structures ranging from nano to micro scale, which is mainly determined by the thicknesses of silica deposition. We have applied the nanomembrane to DNA purification, and have evaluated its efficiency by comparing with commercial magnetic particles. Results show that DNA extracted with nanomembrane has higher recovery yield than those extracted with particles. Thicker silica layer leads to larger specific areas thus larger DNA absorption capacity and higher recovery yield. Furthermore, DNA isolated using the nanomembrane display higher purity and better integrity.

(1E1-4) ICE FISHING MICRO CHANNELS WITH SUB-MICRON PORES ……No.467

Justin Young-Hyun Kim[1], Yang Liu[2], Nicholas Scianmarello[2], Penvipha (Yok) Satsanarukkit[2], Yu-Chong Tai[2]
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We report here a micro fluidic device with a controlled opening, which is used for accessing the fluid inside the micro channel from outside. The control of the reduced diameter of the opening pore is achieved by depositing a controlled Parylene layer on a starting lager opening hole. By changing the Parylene type and thickness, we can control the pore size and surface hydrophobicity. Due to the Laplace-Young's pressure induced by the surface tension of the liquid in the vicinity of the pore, the internal fluid can be pressurized without leaking through the pore.

(1E1-5) STRONG SERS FROM GOLD NANOSTRUCTURE SANDWICHED ON SINGLE LAYER GRAPHENE FOR HIGH SENSITIVE BIOMOLECULE DETECTION ……No.462

Hung-Yao Chu, Judy M. Obliosca, Pen-Cheng Wang, and Fan-Gang Tseng
Engineering and System Science Department, National Tsing Hua University, Hsinchu, Taiwan
In this paper, we introduce a simple and highthroughput technique for developing a strong surface-enhanced-Raman-Scattering (SERS) sensor by sandwiching dual gold nanoparticle (GNPs) on single layer graphene (SLG) for biomolecule detection. Through this way, the overall nanostructure size can be much closer to 10 nm which is more suitable for individual biomolecule sensing.

14:15-15:30	Session:1B2	Session:1C2	Session:1D2	Session:1E2
Room	F1	M2	M3	EIII
Topic	Micro/nano Fabrication & Metrology 2	Nanomaterials 2	Cross-Starit Inivted Session 2	Best Student Paper
Chair &Co-Chair	Xiongying Ye & Slaughter Gymama	Wengang Wu & Chengkuo Lee	Chao-Min Cheng & Baoqin Chen	Gwobin Lee & Shanhong Xia
Paper ID	375, 341, 365, 336,504	356,439,478,491,497,544	273,307,298,392	281,283,351,453,165

14:15-15:30 Session: 1B2 Micro/nano Fabrication & Metrology 2 Room F1

Chair&Co-Chair: Xiongying Ye & Slaughter Gymama

(1B2-1) FACILE AND VERSATILE REPLICATION OF HIGH-PERFORMANCE SUPERLYOPHOBIC SURFACES ON CURABLE SUBSTRATES USING ELASTOMER MOLDS ……No.375

Lifang Yuan[1], Zhaoyun Guan[1], Weiji Zhang[1], Yuji Suzuki[2], Rong Xiang[1], Xuchun Gui[1], Yuan Zhu[1], Zikang Tang[1,3,4], Liang Zhang[5] and Tianzhun Wu[1]
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[3]*State Key Lab of Optoelectronic Materials & Technologies, Sun Yat-sen University, Guangzhou, China*
[4]*Department of Physics, Hong Kong University of Science and Technology, Hong Kong, China*
[5]*Key Lab for New Drugs Research of Traditional Chinese Medicines Shenzhen, Research Institute of Tsinghua University in Shenzhen, Shenzhen, China*
We have developed a facile, versatile and low-cost fabrication method for high-performance superlyophobic surfaces (SLS, simultaneously superhydrophobic and superoeleophobic) on curable materials, which is promising to unblock the two bottlenecks of SLS (relying on very few materials and requiring demanding fabrication). By using poly(dimethylsiloxane) (PDMS) as the elastomer mold, T-shape microstructures of Si-based SLS were readily transferred to poly(methyl methacrylate) (PMMA) with high precision, high fidelity and comparable non-wetting performances. The repeatable and durable use of Si and PDMS allowed mass production of SLS on various curable materials without significant deterioration, and dramatically diluted the fabrication cost. We believe this method may initialize the high-throughput, high-performance and low-cost SLS fabrication on various substrates.

(1B2-2) A NOVEL METHOD TO FABRICATE SILICON NANOPORE ARRAYS ……No.341
T. Deng, C. Zhao, J. Chen, Z. Liu
Institute of Microelectronics, Tsinghua University, Beijing, China
This paper presents a novel method for fabrication of silicon nanopore arrays. The proposed method comprises of an inductive coupled plasma (ICP) deep etching and a two-step anisotropic wet etching. A nanopore array with an average feature size of 55 nm and several individual rectangular nanopores with feature sizes as small as 18 nm were successfully obtained using this method. These results indicate the potential of this method for the large-scale production of nanopores arrays with desired sizes and shapes.

(1B2-3) SUSPENDED MAGNETIC POLYMER STRUCTURES FABRICATED WITH EXPOSURE DOSE CONTROL ……No.365
Jui-Chang Kuo, Chong-Shuo Li, and Yao-Joe Yang
Department of Mechanical Engineering, National Taiwan University, Taiwan
This work presents a fabrication process for realizing suspended magnetic polymer structures with SU-8 photoresist dispersed with Fe3O4 nano-particle. By controlling the exposure doses of ultraviolet (UV) light, the floating structure is patterned at the first exposure, and then the anchor structure is patterned at the second exposure. Suspended magnetic polymer structures such as doubly-clamped beams and circular diaphragms can be fabricated successfully after releasing from one development process. In addition, the functionalities and characterizations of the realized magnetic doubly-clamped beam were demonstrated and discussed. The resonant frequencies of the structure were measured under sinusoidal magnetic fields with an amplitude of 10.37 mT. The resonant frequencies of the structures with 5 mm and 6 mm in length are 5.21 kHz and 4.18 kHz, respectively.

(1B2-4) A DIRECT-WRITE LARGE PVDF NANOFIBER ARRAYS BY MEANS OF HOLLOW CYLINDRICAL NEAR-FIELD ELECTROSPINING PROCESS ……No.336

Z.H. Liu[1], C.T. Pan[1], L.W. Lin[2], Y.L. Lin[1], Z.Y. Ou[1]
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In this study, HCNFES (hollow cylindrical near-field electrospining) process was explored to fabricate permanent piezoelectricity of PVDF (polyvinylidene fluoride) piezoelectric nanofibers. Under high in-situ electric poling (5×10^6-1.6×10^7 V/m) and strong mechanical stretching effect (rotating velocity of the tube collector: 900-1900 r.p.m, tangential speed 942-1989.3 mm/s) during HCNFES process (Fig. 1), large PVDF nanofiber array (see Fig. 2) with high piezoelectric β-phase crystallisation was demonstrated. PVDF nanofibers were spun on a PET (polyethylene terephthalate) substrate; silver paste was applied at both ends of fibers to fix their two ends tightly on a Cu (copper) foil electrode pair. The entire structure was packaged inside a thin flexible polymer to maintain its mechanical stability (Fig. 6). Repeatedly stretching and releasing the nanoharvester with a strain of 0.05 % at 7 Hz vibration, a maximum peak voltage and current of -76 mV (Fig. 7(a)) and -10 nA (Fig. 7(b)) can be obtained, respectively.

(1B2-5) FABRICATION OF ARRAYED ASPHERIC MICROLENS BY EXCIMER LASER AND APPLIED TO MASK-LESS BEAM PEN LITHOGRAPHY ……No.504

Chi-Cheng Chiu, Chih-Hao Chang, Cing-Yun Lu and Yung-Chun Lee
National Cheng Kung University, Taiwan
This paper reports the fabrication on an array of microlenses which have an optimally designed aspheric lens profile for the application of mask-less beam pen lithography. The microlens array is fabricated using an excimer laser micromachining system along with a contour mask and a bi-axial scanning method. The microlenses are fabricated using a laboratory-built KrF 248 nm excimer laser micromachining system. The overall machined area of the microlens array is 13×13 mm^2 which consists of an array of 106×106 microlenses. To demonstrate the capability of this mask-less beam pen lithography system, A metallic pattern with an array of characters of "NCKU" that are first "written" by the UV bean pens on a thin AZ1500 PR layer. The minimal line-width of these characters is around 1.23 μm.

14:15-15:30 Session: 1C2 Nanomaterials 2 Room M2

Chair&Co-Chair: Wengang Wu & Chengkuo Lee

(1C2-1) THE EFFECT OF OUT-OF-PLANE STRAIN ON THE ELECTRONIC PROPERTIES OF ZIGZAG GRAPHENE NANORIBBONS ……No.356

Xiaohui Hu, Xiao Xie, Litao Sun
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We have studied the influence of out-of-plane strain on the electronic properties of zigzag graphene nanoribbons (ZGNRs) using first principles methods. We find that the electronic properties of ZGNRs are highly sensitive to the strains. As the strain increases, the band gap first remains almost invariant and then decreases monotonically, which could be used to design high precision strain sensors. ZGNRs based sensors would possess higher sensitivity and quicker response compared to the conventional sensors.

(1C2-2) CONTROLLABLE PREPARATION AND CHARACTERIZATION OF GRAPHENE-BASED COBALT OXIDE NANOCOMPOSITES ……No.439

Jing Ji, Kuibo Yin, Litao Sun
SEU-FEI Nano-Pico Center, Key Laboratory of MEMS of Ministry of Education, Southeast University, Nanjing, China
Here we introduce a facile hydrothermal synthesis for the controllable growth of cobalt oxide (Co_3O_4) nanoparticles onto graphene nanostructures. The Co_3O_4 particles were monodispersive with a grain size less than 10 nm and homogeneously anchored on graphene sheets. The effects of oxidants, reaction temperatures, and reaction times on the microstructures of final products were investigated, respectively. The obtained material was characterized by transmission electron microscopy (TEM) and high-resolution TEM (HRTEM).

(1C2-3) SPRAY DEPOSITED $CuInS_2/TiO_2$ THIN FILM SOLAR CELLS ……No.478

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Department of Electronics Engineering, Engineering,King Mongkut's Institute of Technology Ladkrabang, Ladkrabang, Thailand
Copper indium sulfide (CIS) solar cells with Ag/CIS/TiO_2/FTO/glass structure were fabricated by nonvacuum methods. The nanoporous TiO_2 and nanocrystalline CIS films were prepared by screen-printing and spray pyrolysis techniques, respectively. The obtained films were examined using field-emission scanning electron microscopy and X-ray diffraction. The solar cell properties were characterized under AM 1.5. The porous nature of TiO_2 layer was found to cause the formation of nanocrystalline CIS with a very small grain size within the TiO_2 matrix. The photocurrent could not be observed in any devices without a TiO_2 layer (i.e. CIS/FTO), while it was detected for the devices consisting of TiO_2 layer (i.e.CIS/ TiO_2/FTO). The thickness of TiO_2 layer was optimized for maximum efficiency. The highest efficiency obtained solar cells was 2.29×10^{-5}% (Voc: 0.147 V, Jsc: 6.52×10^{-7}A/cm2, FF: 0.24) with a 3-μm-thick TiO_2.

(1C2-4) INDENTATION-INDUCED TWO-WAY SHAPE-MEMORY EFFECT IN NiTi ……No.491

Nicolas J. Peter[1], Mareike Frensemeier[1], Enwei Qin[1], Carl P. Frick[2], Eduard Arzt[1,3], Andreas S. Schneider[1],

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[3]*Saarland University, 66123 Saarbrücken, Germany*
The indentation-induced shape-memory behavior in both an aged and a solutionized austenitic nickel-titanium (NiTi) alloy was investigated by Vickers indentation. The depth recovery ratio of the indents as well as the formation of protrusions on the surface after planarization was analyzed after the sample was heated above and cooled below the phase transformation temperature using a white light interferometer. For comparison a solutionized, fully austenitic sample was subjected to the same indentation parameters and temperature changes. The results show that indentation induces a one-way and two-way shape-memory effect in the aged material containing small fractions of martensite and precipitates. In contrast, the solutionized fully austenitic sample shows less pronounced one-way compared to the aged material and no two-way shape recovery. This phenomenon is discussed in terms of martensite stabilization by precipitates and dislocations.

(1C2-5) ORGANIC-INORGANIC LIPID NANOFIBERS ENABLING ANTIBODY IMMOBILIZATION AND CELL CAPTURE ……No.497

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[2]*Biomedical Engineering Program and Bio5 Institute, University of Arizona, Tucson, USA*
[3]*Department of Biomedical Engineering, Peking University, Beijing, China*
A biomimetic strategy is employed to functionalize organic-inorganic cholesteryl-succinyl silane (CSS) nanofibers with membrane-bound antibodies (Abs). Fluorescent microscopy and a cell capture assay confirm the stable and functional immobilization of Abs on the electrospun CSS nanofibers. An insert-and-tighten mechanism is proposed for the observed hydration-induced reduction in lipid nanofiber diameter and the immobilization of Abs. Subsequently, the anti-CD20 functionalized CSS nanofibers display greater ability to capture Granta-22 cells than their film counterparts, suggesting that nanotopography plays an important role in antibody immobilization and cell capture. The ability to stably and functionally immobilize Abs on the CSS nanofibers presents a promising method to functionalize lipid-based nanomaterials.

(1C2-6) MOLECULAR DYNAMICS SIMULATION OF NANOINDENTATION FOR SINGLE-LAYER RECTANGULAR GRAPHENE FILM ……No.544

Weidong Wang[1], Yongjie Zhan[2], Minglin Li[3]
[1]*School of Electrical and Mechanical Engineering, Xidian University, China*
[2]*Physics Department, Northwest University, China*
[3]*School of Mechanical Engineering and Automation, Fuzhou University, China*
Base on Tersoff and Lernnard-Jones potentials, molecular dynamics simulation of nanoindentation experiment on single layer rectangular graphene film is carried out. A typical force-displacement curve is obtained and the effects of various factors including indenter radius, velocities as well as boundary conditions on the simulation results are discussed. The Young's modulus and the strength of the graphene are measured as 1 terepascals and 90 gigapascals, respectively.

14:15-15:30 Session: 1D2 Cross-Starit Inivted Session 2 Room M3

Chair&Co-Chair: Chao-Min Cheng & Baoqin Chen

(1D2-1) ADVANCES OF CMOS-MEMS TECHNOLOGY FOR RESONATOR APPLICATIONS ……No.273

Sheng-Shian Li
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This paper reports on recent progress on high-*Q* integrated micromechanical resonators using "CMOS-MEMS technology" to enable monolithic integration of MEMS and CMOS. Specifically, we take advantage of IC and semiconductor strength in Taiwan to develop several CMOS-MEMS resonator platforms targeted for inherent integration of MEMS and circuitry towards single-chip implementation for timing reference and oscillator applications. In addition, performance enhancement in terms of motional impedance, power handling, linearity, thermal stability, frequency tunability, quality factor, and feedthrough level have been addressed.

(1D2-2) DISSOLUBLDISSOLUBLE CROSS-LINKED POLYMER MATERIAL FOR UV-CURING NANOIMPRINT LITHOGRAPHY ……No.307

Xin Hu, Haixiong Ge
National Laboratory of Solid State Microstructures, Nanjing University, Nanjing, 210093, China
Insolublity of highly cross-linked nanoimprint resist is a serious problem for template cleaning and liftoff process. The ability to produce high modulus, decomposable cross-linked resist is very attractive. In this paper, we designed and synthesized a diacrylate cyclic degradable cross-linker, 2,10-diacryloyloxymethyl-1,4,9,12-tetraoxaspiro[4.2.4.2] tetradecane (DAMTT). Resists formulated with DAMTT exhibits excellent mechanical properties for high resolution imprint. High resolution patterns are faithfully imprinted on silicon substrates by using the degradable resist. DAMTT incorporated with siloxane is high O2 etch resistance and is used as etch barrier to fabricate high aspect ratio structures. A lift off process could be solely achieve by the same UV-cured resist without the assistance of the thermal plastic under layer, and it can also be used as a liftoff-layer instead of thermal plastic polymers. The cross-linked network can rapidly hydrolyze in boiled 10% p-toluenesulfonic acid solution and foul template is completely cleaned.

(1D2-3) OVIDUCT -MIMETIC CHIP FOR SPERM SEPARATION AND OOCYTE MANIPULATION TO ENHANCE THE PROBABILITY OF FERTILIZATION FOR OLIGOZOOSPERMIA PATIENT ……No.298

Hsin-Yao Tseng[1], Yu-Hsuan Huang[1], Hong-Yuan Huang[2], and Da-Jeng Yao[1]
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[2]*Department of Obstetrics and Gynecology, Lin-Kou Medical Center, Chang Gung Memorial Hospital, Taiwan*
This study presents an imitation of oviduct microfluidic dielectrophoresis chip system. In this research, ICR mouse's oocyte trapped by insulator-structure microchannel of a dielectrophoresis system will be shown. In order to reduce the impact and destruction of cells, this study adopts dielectrophoresis force to manipulate the cell. Imitation of In Vitro Fertilization, the natural fertilization of sperm and oocytes in the microfluidic channel, the collision frequency between sperms and oocyte plays the success key role of the IVF. The numerical simulation software, CFDRC, was used to reveal the position of high and low electric field distribution in microchannel. The positive dielectrophoresis response of oocyte was exhibited with the frequency at 1 MHz, the oocyte will move to the region with high electric field density. The pattern of insulating structure was fabricated by SU8-3050 to generate non-uniform electric field to trap oocyte with positive dielectrophoresis. Finally, the positive DEP was used to drive the position of cells in the microchannel structures.

(1D2-4) ELECTRO-THERMAL MICRO ACTUATORS BY Ni-BASED MICROMACHINING PROCESS ……No.392
Wensyang Hsu[1], Yu-Ting Cheng[2]
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Comparing to silicon-based materials, metal can provide lower resistivity and higher coefficient of thermal expansion. Here several novel electro-thermal micro actuators developed in our group by Si-based and Ni-based micromachining process are presented, including long-short beam actuator, long-stroke actuator, and lifted 3D actuator through micro resistance welding. Also, by incorporating nano particles in electroplating process, Ni-based nanocomposite is found to provide even higher coefficient of thermal expansion than pure Ni to further enhance performance of electro-thermal micro actuator.

14:15-15:30 Session: 1E2 Best Student Paper Room EIII

Chair&Co-Chair: Gwobin Lee & Shanhong Xia

(1E2-1) DUAL-GATE SILICON CARBIDE (SiC) LATERAL NANOELECTROMECHANICAL SWITCHES ……No.281
Tina He, Rui Yang, Srihari Rajgopal, Swarup K. Bhunia, Mehran Mehregany, Philip X.-L. Feng
Electrical Engineering, Case Western Reserve University, Cleveland, OH 44106, USA
We present demonstration and experimental results of four-terminal nanoscale electromechanical switches with a novel dual-gate design in a lateral configuration based on polycrystalline silicon carbide (poly-SiC) nanocantilevers. The switches operate at both room temperature and high temperature up to $T \approx 500℃$ in ambient air with enhanced control over the *distributed* electrostatic actuation force, and also enable recovery from stiction at contact. We have experimentally demonstrated multiple switching cycles of these nanomechanical switches with different actuation control schemes, and active release from stiction by exploiting a repulsive mechanism. In combination with modeling of cantilever deflection, the experiments help reveal the coupled electromechanical behavior of the device when making contact during switching operations, and suggest possible correlation between the switch degradation observed over cycles and the elastic deformation of nanocantilevers.

(1E2-2) A BI-STABLE SILICON NANOFIN NANOELECTROMECHANICAL SWITCH BASED ON VAN DER WAALS FORCE FOR NON-VOLATILE MEMORY APPLICATIONS ……No.283
Bo Woon Soon[1,2], Navab Singh[1], Julius Minglin Tsai[1] and Chengkuo Lee[2]
[1]*Institute of Microelectronics, A*STAR (Agency for Science, Technology and Research), Singapore*
[2]*Department of Electrical and Computer Engineering, National University of Singapore, Singapore*
We present a silicon nanofin (Si-NF) which can be actuated bi-directionally by electrostatic force between two contact surfaces. The switch is able to maintain its contact leveraging on van der Waals force that holds the Si-NF to either terminal without on-hold bias, thus showing a bi-stable hysteresis behavior. The measured pull-in voltage VPI and VRESET is 10V and -12V respectively, confirming that the switch can be reset by the opposite electrode. Since the switch toggles between two stable states, therefore it can be an ideal device for non-volatile memory (NVM) application.

(1E2-3) THERMOELECTRIC PROPERTIES INVESTIGATION OF SINGLE NANOWIRES BY UTILIZING A THERMOELECTRIC NANOWIRE CHARACTERIZATION PLATFORM ……No.351
Zhi Wang[1], Johannes Ruhhammer[1], Shyam Adhikari[1], Raimar Rostek[1], Dominik Moser[2], Oliver Paul[2], Danny Kojda[3], Ruediger Mitdank[3], Saskia F. Fischer[3], William Toellner[4], Kornelius Nielsch[4], Michael Kroener[1] and Peter Woias[1]
[1]*Laboratory for Design of Microsystems, Department of Microsystems Engineering - IMTEK, University of Freiburg, Germany*
[2]*Microsystems Materials Laboratory, Department of Microsystems Engineering - IMTEK, University of Freiburg, Germany*
[3]*Novel Materials, Humboldt-Universität zu Berlin, Germany*
[4]*Institut für Angewandte Physik, Universität Hamburg, Germany*
We demonstrate the design and fabrication of a novel micromachined Thermoelectric Nanowire Characterization Platform (TNCP) which is utilized to characterize the thermoelectric properties of various nanowires. Single nanowire is assembled onto the pre-fabricated TNCP by means of dielectrophoresis (DEP) in combination with a water droplet evaporation scheme. After assembly, a reliable ohmic contact is generated between the bismuth telluride (Bi_2Te_3) nanowire and the underlying electrodes by means of scanning electron microscope (SEM) focused electron beam-induced deposition (EBID). Finally, the electrical conductivity and Seebeck coefficient of Silver (Ag) and Bi_2Te_3 nanowires are investigated and presented.

(1E2-4) CONTROLLABLE FORMATION AND OPTICAL CHARACTERIZATION OF SILICON NANOCONE-FOREST USING SF_6/C_4F_8 IN CYCLIC ETCHING-PASSIVATION PROCESS ……No.453

Fu-Yun Zhu, Xiao-Sheng Zhang, Wei Hu, and Hai-Xia Zhang
Science and Technology on Micro/Nano Fabrication Lab, Peking University, Beijing, China
This paper reports a nanocone-forest silicon surface fabricated by an improved DRIE process using SF6/C4F8 in cyclic etching–passivation process, which is maskless, controllable, effective and large-size. As well known, optical property of textured silicon surface is determined mainly by its surface structure, and surface structure is determined by process conditions. In this work, process conditions during the experiment, like etching process parameters, pretreatment, uniformity control and patterned silicon etching, are tested and discussed. Based on these controllable process conditions, nanocone-forest with an average height of 0.4~5μm, aspect ratio of 1~8 and density of 3~30 per 4μm^2 formed. By analyzing the influences of nanostructure parameters on optical property, it's concluded that high aspect ratio, high density and small height of nanostructure could result in ultra-low reflectance. The optical reflectance of two samples has been reduced to below 0.22% and 0.16% of the solar spectrum, respectively.

(1E2-5) DESIGN AND IMPLEMENTATION OF AN ON-CHIP POLYMER MICRO BALL BEARING ……No.165
Chih-Chun Lee[1], Yu-Che Huang[2], Wen-Hsiung Hsiao[2], and Weileun Fang[1,2]
[1]*Institute of NanoEngineering and MicroSystems*
[2]*Department of Power Mechanical Engineering, National Tsing Hua University, Taiwan*
This study presents a novel design and fabrication process to realize an on-chip micro ball bearing. The ball bearing consists of a polymer-Si-polymer outer-race (stator), and a suspended polymer-Si-polymer inner-disk (rotor) supported by polymer micro-balls. The outer-race and inner-disk are demolded from silicon mold, which is patterned by wet isotropic etching on double-polished 525 μm-thick silicon wafer. The liquid phase photocurable polymer balls are dispensed by commercial dispenser with a hundred micrometer diameter tip and in-situ self-assembled in buffer liquid. After photocurable polymer solidified by UV-curing, the polymer balls are confined between the outer race and inner disk. Note the ball bearing is fabricated on a single wafer with no assembly required.

15:30-15:45 **Coffee Break and Exhibition**

15:45-17:00	Session:1B3	Session:1C3	Session:1D3	Session:1E3
Room	F1	M2	M3	EIII
Topic	Micro/nano Fabrication & Metrology 3	Carbon Nanotube & Graphen based Devices	Cross-Starit Inivted Session 3	CM Ho Microfluidics Award
Chair &Co-Chair	Joan Bausells & Shiyuan Liu	Jianning Ding & Bo Cui	Rong Zhu & Shikang Fan	Chihming Ho & Gwobin Lee
Paper ID	391,438,450,488,500,519	334,490,496,264,399,460	276,458,373,352	517,529,108,196,109

15:45-17:00 Session: 1B3 Micro/nano Fabrication & Metrology 3 Room F1
Chair&Co-Chair: Joan Bausells & Shiyuan Liu

(1B3-1) FABRICATION OF ANISOTROPIC NANOMATERIAL BY PRECISE AND LARGE-AREA NANOWIRE OPERATION WITH FOCUSED-ION-BEAM ……No.391
Lurui Zhao[1], Can Li[1], Didi She[1], Zhiqiang Wang[1], Jun Xu[2], Wengang Wu[1]
[1]*National Key Laboratory of Science and Technology on Micro/Nano Fabrication, Peking University, China*
[2]*Electron Microscopy Laboratory, Peking University, China*
This paper presents a fabrication method for anisotropic nanomaterial by operating nanowires by focused-ion-beam (FIB) irradiation. After the preparation of one-dimensional nanowire, FIB irradiation is applied on the nanowire to operate its orientation and morphology by choosing irradiation position and area. On one hand, localized FIB irradiation is employed to precisely operate the morphology of the planar ultra-fine nanowire prepared by FIB induced fluidization and self-perfect process driven by the material diffusion process. On the other hand, large area FIB scanning is applied to achieve the orientation adjustment of high-density nanowire bunch and nanoforest obtained by oxygen plasma etching. When nanowire is irradiated, unbalanced stress is introduced at different side, and thus nanowire bends to balance the stress. Based on this approach, both single and large area of nanowire structure can be controlled, and anisotropic nanomaterial is realized.

(1B3-2) HIGH ASPECT RATIO ETCHING OF NANOPORES IN PECVD SiC THROUGH AAO MASK ……No.438
Songmei Wu[1], Marc-Oliver Bammatter[1,2], Wei Tang[2], Vaida Auzelyte[1], Haixia Zhang[2], Juergen Brugger[1]
[1]*Microsystems laboratory, EPFL STI-IMT-LMIS1, Switzerland*
[2]*National Key Laboratory on Micro/Nano Fabrication Technology, Institute of Microelectronics, Peking University, China*
We present in this work the fabrication of high aspect ratio nanopores in 500 nm PECVD SiC films through AAO (anodic aluminum oxide) mask. The initial AAO thin film is 180 nm thick and the diameter of nanopores is 33 ± 7 nm. We have used three plasma chemistries: CF_4, Cl_2 /Ar, and SF_6/O_2 to study the pattern transfer process into SiC at sub-50 nm scale by deep reactive ion etching. CF_4 and Cl_2/Ar etchings show highly anisotropic features. Vertical pores with similar diameter as the AAO mask (33 ± 12 nm) and as deep as 400 nm (aspect ratio >10) can be achieved by CF_4 reactant. As

comparison, SF_6 /O_2 chemistry generates very different etching profiles, causing trenches both in vertical and lateral directions. Our PECVD SiC nanopores are promising candidates for robust biosensing and nanofiltration applications.

(1B3-3) NANOSTRUCTURE FABRICATED BY LASER DIRECT WRITING WITH WATER DROPLETS ……No.450

Y. J. Chang, C. H. Chang, C. C. Ho, J. C. Hsu, C. L. Kuo

Department of Mechanical Engineering, National Yunlin University of Science and Technology, Douliou, Taiwan

Nanopatterning using near-field optics has shown great potential for industrial applications. A novel application of water droplets to this technology is proposed in this study. With a hydrophobic layer and controlled substrate temperature, a layer of randomly distributed water droplets with a high contact angle is formed on the substrate. These liquid droplets can be used as lenses to enhance the laser intensity at the bottom of the droplets.As a result, nanoscale holes can be formed on the substrate by laser ablation. We have fabricated holes with a diameter of 500nm at the substrate temperature of 12℃. The depth of the holes ranges from 0.1μm to 0.9μm, depending on the diameter of droplets.

(1B3-4) POLYMERIC HEMISPHERICAL PICO-LITER MICRO CUPS FABRICATED BY INKJET PRINTING …No.488

L. Jacot-Descombes, M. R. Gullo, V. J. Cadarso, M. Mastrangeli, J. Brugger

Microsystems Laboratory, EPFL, 1015 Lausanne, Switzerland

The fabrication of precise hemispherical shape is challenging with standard planar lithography techniques. A suitable alternative is the fabrication by inkjet printing. This paper presents a method based on drop-on-demand inkjet printing on pre-patterned silicon substrates allowing the controlled fabrication of SU-8 hemispherical cup-like structures with inner cavities of sub-nano-liter volumes. Examples are given for cups of 100μm in diameter with inner cavity volumes of 5pL, 20pL and 45pL. Arrays of 360 hemispherical SU-8 cups have been fabricated with a yield above 96%. The 4% of exceptions are also described and shown as a method for achieving almost complete SU-8 spheres.

(1B3-5) NANOFABRICATION ON NON-FLAT SURFACE USING EVAPORATED ELECTRON BEAM RESIST …No.500

Jian Zhang and Bo Cui

Department of Electrical and Computer Engineering, University of Waterloo, Waterloo, Ontario, Canada

Electron beam resist is typically applied by spin-coating, which is not suitable for coating on non-flat surfaces, such as a scanning probe cantilever or the end or side of an optical fiber. Here we present electron beam lithography result on non-flat surface (an AFM cantilever) by using polystyrene resist that is thermally evaporated, which can thus be coated on any surface. We achieved high resolution of ~30 nm using this evaporated resist.

(1B3-6) PROTEIN MICRO/NANO-ELEMENTS FOR GREEN BIOPHOTONICS VIA FEMTOSECOND LASER DIRECT WRITING ……No.519

Yun-Lu Sun[1], Wen-Fei Dong[1], Hong-Bo Sun[1, 2]

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[2]*College of Physics, Jilin University, 119 Jiefang Road, Changchun 130023, China*

Protein-hydrogel-based free-form three-dimensional (3D) micro/nano-elements with „„smart"" stimuli-responsiveness fabricated via femtosecond laser direct writing (FsLDW) are rapidly emerging for their wide utility in many fields, such as bio-micro/nano-machine [1], bionics [2], and biophotonics [3, 4], etc. Here, we applied the promising protein-FsLDW approach in the construction of protein-based 3D optical microdevices, for example, microlenses. In order to meet the requirements of optical applications, processing parameters were optimized to achieve high surface quality and fine 3D morphology. The photo-crosslinked protein microhydrogels showed a rapid and reversible swell-to-shrink behaviour once stimulated by chemical signals, by which the protein microdevices can be dynamically tuned. Because of using protein molecules as "building blocks", protein-based microelements were demonstrated of fine biocompatibility. Based on the valuable characteristics, protein-based optical micro/nano-elements have great potential for micro/nano-bio-optics and bionics, etc.

15:45-17:00 Session: 1C3 Carbon Nanotube & Graphen based Devices Room M2

Chair&Co-Chair: Jianning Ding & Bo Cui

(1C3-1) HYDROGEN ETCHING EFFECT ON SINGLE-CRYSTAL GRAPHENE DOMAINS ……No.334

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[1]*Science and Technology on Microsystem Laboratory, State Key Laboratories of Transducer Technology, Shanghai Institute of Microsystem and Information Technology, CAS, Shanghai, China*

[2]*Graduate School of Chinese Academy of Science, Beijing, China*

In this paper, the anisotropic hydrogen etching effect on chemical vapor deposited sing-crystal graphene domains was reported. After synthesized by chemical vapor deposition on copper foils, the graphene domains were exposed to a mixed gas flow of argon and hydrogen for etching. By varying the etching temperature from 800℃ to 1050℃, hexagonal openings inside the graphene domains were found on hydrogen etched samples. The dependence of substrate was then studied and the result indicated that copper was necessary in the etching process as catalyst. At last, etching experiments were performed on high quality single-crystal graphene domains, and the result showed that the hexagonal single-crystal graphene domains were etched to circular.

(1C3-2) TUNABLE GRAPHENE NANOMESH SEMICONDUCTOR: DESIGN, FABRICATION, AND CHARACTERIZATION ……No.490

Haider Al-Mumen, Fubo Rao, Lixin Dong and Wen Li

Electrical and Computer Engineering , Michigan State University, East Lansing, Michigan, USA

This paper reported a technique for tuning graphene semiconductor properties by introducing nanoholes into single- and few-layer graphene films. A simple nanofabrication technique has been demonstrated for making periodic nanoholes on pristine graphene in a mask-free and time-efficient manner via direct e-beam writing which was done by simply scanning the graphene area that is covered with EBL resist and then etching the scanned area by oxygen plasma. Parameters of e-beam lithography (EBL) (acceleration voltage, beam current, EBL resist thickness, and scanning area) were fine-tuned to optimize the dimensions of the nanomesh. Finally, Graphene field effect transistors were fabricated and characterized experimentally.

(1C3-3) DESIGN, FABRICATION, AND CHARACTERIZATION OF GRAPHENE THERMISTOR ……No.496

Haider Al-Mumen, Fubo Rao, Lixin Dong and Wen Li
Electrical and Computer Engineering, Michigan State University, USA

This paper reported a new application of graphene that is graphened thermistor. Mono-layer, bi-layer and few-layer graphene devices with different dimensions were designed and fabricated. Temperature sensing behavior of graphene has been studied in a small temperature range from room temperature (RT) to 80℃ because this range is important in electronic instrumentations and integrated circuit design. Thermal inertia of the graphenes was studied at a temperature of 80°C and the sensing behavior was characterized by measuring the time response of the normalized resistances. Our preliminary results demonstrated a higher negative temperature coefficient of the bi-layer graphene those of mono-layer and few-layer graphenes. In addition, engineered graphene resistance based on its dimension has been investigated. This technique provides a strong candidate for temperature sensing in the micro and nano industrial applications with high reliability, high sensitivity and low cost.

(1C3-4) MICROELECTROFORMING OF A NICKEL NOZZLE PLATE FEATURED WITH ANTI-STICTION FOR A PIEZOELECTRIC ATOMIZER ……No.264

Jheng-Jhih Huang, Chin-Tai Chen
Mechanical Engineering, National Kaohsiung University of Applied Sciences, Kaohsiung, Taiwan

Micro atomizers have been popular over decades for many applications such as cooling, medical care and inkjet printing that were driven by reciprocal piezoelectric effect. The paper presents a simple but user-friendly design for the production of a piezoelectric atomizer utilizing a nickel nozzle plate with micro anti-stiction cavities on surface. Two PMMA substrates are specifically designed and bonded to carry out the capping, forming a micro atomizer in the study. Micro droplets (each volume ~ 36 pl) are able to be jetted out of the fluidic nozzles with a typical diameter of ~ 30 μm by driving the back piezoelectric plate. The thermal images of infrared thermograph into the spraying space are captured and analyzed for this cooling process.

(1C3-5) LABEL-FREE SEPARATION AND SORTING OF HUMAN MONOCYTES AND T-CELLS BY ELECTROWETTING AND DIELECTROPHORESIS ……No.399

Cheng-Yeh Huang[1], Min-Yu Chiang[2], Shih-Kang Fan[3], Amir M. Ghaemmaghami[4], and Wensyang Hsu[1]
[1]*Department of Mechanical Engineering, National Chiao Tung University, Taiwan*
[2]*Department of Materials Science and Engineering, National Chiao Tung University, Taiwan*
[3]*Department of Mechanical Engineering, National Taiwan University, Taiwan*
[4]*Allergy Research Group, Faculty of Medicine, University of Nottingham, United Kingdom*

We report a label-free separation and sorting approach based on electrowetting-on-dielectric (EWOD) and dielectrophoresis (DEP) to manipulate human monocyte (THP-1) and T-cell (Jurkat) lines in droplets without any impact on cell viability. In addition to separating cells, this device provides a platform to study cell-cell interactions and migration before the separation.

(1C3-6) A CAPILLARY-BASED MICROFLUIDIC DEVICE INCORPORATING OPTICAL FIBERS FOR FLOW INDUCED DISPERSION ANALYSIS ……No.460

Guisheng Zhuang, Nicklas N. Poulsen, Nickolaj J. Petersen, Jesper Østergaard, Henrik Jensen
Department of Pharmacy, Faculty of Health and Medical Sciences, University of Copenhagen, Copenhagen, Denmark

In this paper, we describe a capillary-based microfluidic device utilizing flow induced dispersion analysis (FIDA) for quantitative characterization of biomarkers. The microfluidic device is fabricated by micromilling technology and has incorporated buried optical fibers for light detection. The angle and distance between the fiber guiding the excitation light source and the fiber collecting fluorescent emission light were optimized to enhance signal-to-noise ratio (SNR) and limit of detection (LOD). The prototype achieves a LOD of 50 nM for the fluorescein indicator by using a low-cost Miniature Fiber Optic Spectrometer. The FIDA-based procedure employing fluorescein as the indicator and human serum albumin (HSA) as the analyte is carried out in the microfluidic device.

15:45-17:00 Session: 1D3 Cross-Starit Inivted Session 3 Room M3

Chair&Co-Chair: Rong Zhu & Shikang Fan

(1D3-1) IDENTIFICATION OF LIGAND-RECEPTOR BINDING AFFINITY USING ALGAN/GAN HIGH ELECTRON MOBILITY TRANSISTORS AND BINDING-SITE MODELS ……No.276

Yu-Lin Wang, Chih-Cheng Huang, You-Ren Hsu, Yen-Wen Kang
Institute of Nanoengineering and Microsystems, National Tsing Hua University, Taiwan

AlGaN/GaN high electron mobility transistors (HEMTs) were immobilized with various receptors, including antibodies, duplex DNA, and HIV reverse transcriptase (RT) enzymes to detect ligands, including peptides, SARS proteins, and HIV drugs, respectively. Signals generated by the sensors were fitted into binding-site models and analyzed. The dissociation constants of the ligand-receptor pairs and the number of binding-sites on receptors were resolved. The HEMTs and the models were demonstrated to be useful for drug developments and for elucidating SARS virus replication.

(1D3-2) DEVELOPMENT OF CMOS-MEMS LOGIC GATES ……No.458

C.-Y. Tsai, T.-L. Chen, C.-M. Wu
Department of Mechanical Engineering, National Chiao Tung University, Shinchu, Taiwan

This paper presents the design and fabrication of a MEMS logic gate that can perform either NAND gate or NOR gate functions using the same mechanical structure, but different electrical interconnects. Two fabrication processes are employed to fabricate this device, which are an in-house developed CMOS-compatible process and a foundry provided CMOS-MEMS process. In the line of in-house process, the experimental results confirm the logic function of the fabricated device. In the line of foundry process, the logic function can only be verified by device's mechanical movements because the contact feature of the device is damaged during the fabrication process. Two methods are then proposed to tackle this problem. One uses titanium nitride (TiN) as the contact material, the other one uses "electrode-less nickel and immersion gold (ENIG)" to deposit gold film on top of aluminum. Both methods are underway and partial success has been observed from experimental data.

(1D3-3) FLEXIBLE POLYMER-BASED MANUFACTURING TECHNOLOGY FOR MICROSTRUCTURE AND ITS APPLICATION ……No.373

Weizheng Yuan, Zefan Shen, Chengqian Zhuang, Pengfei Zhu, Jinjun Deng, Binghe Ma
Key Laboratory of Micro/Nano Systems for Aerospace,Ministry of Education, Northwestern Polytechnical University, Xi'an, China

The purpose of this paper is to introduce flexible polymer-based manufacturing technology for microstructure and its application. Traditional silicon-based MEMS fabrication techniques cannot meet the requirement of flexible fit for the aircraft complex surface. However, the research on flexible thermal sensor array and fully flexible micro balloon actuator array has revealed interesting results. Through wind tunnel test, the flexible thermal sensing belt can be applied on highly curved non-planar surfaces to measure flow with minimal invasion and the fully flexible micro balloon actuator to achieve the goals of boundary layer separation control, lift enhancement, etc. Polymer compatible micromachining technology with consideration of waterproof coating was developed. UAV flight test verifies the ability of maneuver control of micro actuator. In the future work, micro sensor and actuator based on flexible polymer can be combined into a closed-loop control system, and to construct aerodynamic smart skin system for aircraft.

(1D3-4) FABRICATION OF COLLOIDAL CRYSTALS AND THEIR INVERSE OPALS FOR ENGINEERING APPLICATIONS ……No.352

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[2]*Department of Electronics Engineering,National Chiao Tung University, Hsin-chu 300, Taiwan*

We demonstrate a facile fabrication scheme to produce colloidal crystals and their inverse opals in large quantity and reduced defects. The preparation method for the colloidal crystals involves the synthesis of monodispersive polystyrene (PS) microspheres (300-800 nm) and electrophoretic deposition of PS colloids in planar or cylindrical forms. After proper optimization of processing parameters, we are able to obtain colloidal crystals in 5×5 cm^2 with adjustable layer/thickness, and their surface reveals superb uniformity. To produce an inverse structure, the colloidal crystals are used as a template to allow the electroplating of metals (Ag, Ni, Cu, Au), or oxides (ZnO) so the interstitial voids among the PS microspheres are filled. Subsequently, the PS template is carefully removed and an interconnected porous skeleton is formed. With superb structural integrity, the inverse opals can be easily detached from the substrate becoming a free-standing opaline film. Materials characterizations including XRD, nano-indentation, porosity measurements, SEM, electrical conductivity, and α-step are carried out. Lastly, we demonstrate several engineering applications (electrocatalysis, light-emitting diode, wetting and electroweting on dielectric) in which the colloidal crystals and inverses opals provide clear advantages in performance improvements. In addition, we adopt the same process in micrometer-sized channels on a silicon wafer to demonstrate universality of our fabrication scheme and explore possible applications in MEMS applications.

15:45-17:00 Session: 1E3 CM Ho Microfluidics Award Room EIII

Chair&Co-Chair: Chihming Ho & Gwobin Lee

(1E3-1) INTEGRATED DUAL GRATING POLYMER MICROBEAMS FOR BIO-CHEMICAL SENSING IN LIQUID ENVIRONMENT ……No.517

Jin-yang FENG, Xiong-ying YE, Yuan-fang SHANG, Kang WU, Feng CHEN
State Key Laboratory of Precision Measurement Technology and Instruments, Department of Precision Instrument,Tsinghua University, Beijing 100084, China

A polymer microbeam array integrated with dual gratings for interferometric measurement was developed for biochemical sensing in liquid environment. An Au-coated polyimide microbeam structure suspending a centered plate was designed to realize out-plane translational motion. The microbeam array chip was fabricated on a glass substrate based on surface micromachining process. Two adjacent metal gratings corresponding to a microbeam were patterned inside and outside of a groove with the depth of 55 nm to form a phase shift of π/2 to extend the displacement measurement range. The interferometric intensities from the two gratings were detected using a CCD image measurement setup and the displacement of a microbeam was obtained by alternately using intensity signals from the two corresponded gratings. The preliminary experimental results in ethanol show that the detection method with the polymer microbeam chip is available in liquid environment. And antibody-antigen binding detection was also carried out with a rabbit IgG immobilized chip in 100μg/ml goat anti-rabbit IgG solution.

(1E3-2) PHYSICAL MODULATION BASED CELL MANIPULATION IN MICROFLUIDIC DEVICES ……No.529

Jing Zhu[1], Junyi Shang[1], Yuan Jia[1], Kun Liu[1,4], David Brenner[2,3], Qiao Lin[1]
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Cell manipulation has important applications in biological research and clinical diagnostics. We integrate microfabrication with physical modulation to enable selective and flexible cell manipulation, such as isolation, trapping and recovery of cells. We use the strong temperature dependence of affinity binding between aptamers and cells to enable specific capture and controlled temperature-mediated release of cells. We also exploit the large compliance of elastomers to create an array of cell-trapping microstructures, whose dimensions can be mechanically modulated to capture a predetermined number of cells. Thus, enhanced utility and flexibility for practical applications can be attained, as demonstrated by specific capture and temperature-mediated release of CCRF-CEM cells, as well as tunable trapping of MCF-7 cells.

(1E3-3) DYNAMIC CELL ATTACHMENT OF HepG2 IN A MICROCHANNEL ……No.108

Lung-Jieh Yang[1], Chieh-Wen Lu[1], Jia-Chi Liang[1], and Hsieh-Cheng Han[2]
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[2]*National Central University, Taoyuan, Taiwan*
A dynamic filling experiment using PBS with HepG2 tumor cells is performed for observing the attachment behavior in capillaries. A PDMS microchannel mimicking the capillary blood vessel is fabricated by the soft lithography. With treating the PDMS microchannels by different plasmas, the corresponding surface roughness (Ra) data are experimentally measured by AFM. Using these PDMS microchannels well defined by proper Ra values, liquid streams with microbeads and living HepG2 tumor cells are filled in, respectively. The microbead and cell attachment areas in the PDMS microchannel have been recorded dynamically with 10 min interval. Finally, the authors qualitatively discussed the surface roughness effect on the particle or cell attachment in a PDMS microchannel.

(1E3-4) A SYMMETRICAL HYPERBOLIC FORMATTED MICROCHIP FOR RAPID OPTIMIZATION OF ELECTROPORATION ……No.196

Mengxi Wu[1, 3], Deyao Zhao[2], Hao Yan[1], Zicai Liang[2] and Zhihong Li[1]
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We have developed a novel microchip aiming to rapidly optimize of electric parameters for electroporation. The electrodes were designed as symmetrical hyperbolic formatted to generate linearly decrescent electric field. Cells were cultured on the microchip for adherent electroporation and *in-situ* observation. Exhibited diversely in cell viability and transfection efficiency, three areas were observed obviously since the intensity of electric field was varied. Assisted by markers designed on electrodes, the location of optimal electroporation performance area and the corresponding range of electric field intensity were determined. Using the proposed electroporation chip, we obtained the optimal electric field spectrum for electroporation of HEK-293A cell line, that was about 0.75 ~ 1.25 × 10^5 V/m. The diversity of electroporation performance was evaluated by the dependence of cell viability and transfection efficiency on electric field intensity. With the guidance of reference electric field value, we designed a specific annular-interdigitated microchip to testify the electroporation characteristics. At last, we achieved excellent electroporation performance under the optimal conditions using self-made electroporation microchip.

(1E3-5) MANIPULATION OF DNA ORIGAMI NANOTUBES IN LIQUID USING A PROGRAMMABLE TAPPING MODE AFM ……No.109

Longhai Li[1,2], Xiaojun Tian[1], Zaili Dong[1], Lianqing Liu[1], Osamu Tabata[3,4], and Wen J. Li[1,5]
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[5]*Deparment of Mechanical and Biomedical Engineering, City University of Hong Kong, Hong Kong, China*
Deoxyribonucleic acid (DNA) origami [1] is expected to be a nanoscale functional block for Nano Electro Mechanical Systems (NEMS). It can be assembled on a substrate containing other MEMS components to realize a NEMS device in which nanostructures play an important role. We recently demonstrated a tapping mode atomic force microscopy (AFM) process that can manipulate DNA origami structures in liquid to desired positions with controlled orientations, which is a novel process that will eventually allow the constructions of complex nanostructures on substrate surfaces. The manipulation of DNA origami nanotubes with 6 nm in diameter and 400 nm in length placed on a mica substrate was executed by tapping mode AFM with 0-10 nm amplitude. The acting vertical force from the AFM tip to a DNA origami nanotube was calculated to be 25 - 30 nN numerically by using Simulink software (MathWorks). Experimental results shown that ~80% samples can be successfully manipulated if the tapping mode AFM tip amplitude is 3-4 nm.

17:00-19:00

Poster and Exhibition 1 (P1): Poster Number 1P1-1P100 EII

Details of 1P1-1P100 in page 60-78.

Day2: Tuesday, April 9, 2013

8:30-9:15 **2A1 Plenary Speaker 2: Dr. Albert ("Al") P. Pisano (Watson Auditorium)**
Chair: Zhaoying Zhou

(2A1-PS-2) HARSH ENVIRONMENT MEMS FOR ENERGY & POWER APPLICATIONS SINGLE-CHIP, SELF-POWERED, WIRELESS SENSOR SYSTEMS No.2
Albert ("Al") P. Pisano
University of California at Berkeley,USA
Current research and future work will be presented about extreme harsh environment, MEMS wireless sensors fabricated from silicon carbide and aluminum nitride. Harsh environment is defined as temperature at or above 600℃, pressure at or above 300 atm, and shock at or above 50,000 G. These sensors are being integrated with silicon carbide electronics and aluminum nitride energy harvesting devices to build a single-chip, self-powered, wireless sensor system. This wireless sensor system is applicable to power plants, geothermal energy, automobile engines, gas turbines, and other industrial machines that operate at high temperature. A number of thin film materials, suitable for fabrication via MEMS methods, will be described as candidates for application to these sensors. Then, a number of sensors, both existing and under development, will be presented. Integration into silicon carbide electronics will be addressed, and new research results for the fabrication and testing of silicon carbide electronic devices (both active and passive) will be presented. The use of aluminum nitride as a RF component in harsh environments will be described and new results for temperature-compensated radio filters shown. A future vision of a single-chip, self-powered, wireless sensor systems will be described.

9:15-9:45 **2A2 Keynote Speaker 5: David R. S. Cumming (Watson Auditorium)**
Chair: Tie Li & Juergen Brugger

(2A2-KS-5) CMOS INTEGRATION AND SENSING No.21
David R. S. Cumming
Division of Electronics and Nanoscale Engineering, School of Engineering, University of Glasgow, Rankine Building, Oakfield Avenue, Glasgow G12 8LT, United Kingdom
Complementary Metal Oxide Semiconductor (CMOS) underpins all modern microelectronics technology. Whilst dominant in computing and communications components and systems,CMOS has also been hugely influential in imaging technology, displacing other methods of making semiconductor focal plane array sensors such as CCD. In this paper I will describe new developments in CMOS sensing technology, including the CMOS proton sensing array that has growing influence in instrumentation for analytical chemistry and next generation gene sequencing. I will further discuss new sensor technologies based on CMOS for use in terahertz imaging, and the application of emerging technologies in metamaterials and surface plasmon resonance that are set to have a major impact on integrated sensing technologies. In so doing I will show how CMOS is now at the confluence of many strands of research, far outside its original application domain, and how microelectronics and nanoscale engineering has an impact on some of the most demanding technological applications of today.

9:45-10:15 **2A2 Keynote Speaker 6: Isao Shimoyama (Watson Auditorium)**
Chair: Tie Li & Juergen Brugger

(2A2-KS-6) PIEZORESISTIVE CANTILEVER TYPE HIGH SENSITIVE DIFFERENTIAL PRESSURE SENSOR ... No.25
Hidetoshi Takahashi and Isao Shimoyama
Information and Robot Technology Research Initiative, The University of Tokyo, Tokyo, Japan
This paper reports on a differential pressure sensor using a piezoresistive cantilever. Because the three edges of the cantilever are freed up, the sensor has a higher sensitivity than that of a traditional diaphragm sensor. Four types of the cantilever size was designed and fabricated. The highest sensitivity and resolution to differential pressure were 5.6×10^{-4} Pa^{-1}, 0.028 Pa, respectively.

10:15-10:45 **Coffee Break and Exhibition**

10:45-11:15 **2A3 Keynote Speaker 7: Mark G. Allen (Watson Auditorium)**
Chair: Hans Zappe & Yao-Joe Yang

(2A3-KS-7) AN ELECTROPLATING-BASED APPROACH TO VOLUMETRIC NANOMANUFACTURING AND ITS APPLICATION TO ENERGY CONVERSION AND STORAGE..... No.31
Mark G. Allen
School of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, GA, USA
The manufacture of materials with bulk volumes and precisely controlled nanostructure has led to the creation of materials with surprising and useful

mechanical and electrical properties. Recently we have developed a 'top-down' technique based on sequential electroplating that allows the creation of highly-structured multilayer metallic materials, with precisely designed characteristic lengths in the hundreds of nanometers but volumes of manufactured material in the macro range. This electroplatingbased approach also enables batch fabrication of nanostructures. The fabrication relies on automated and repeated multilayer electrodeposition of multiple metallic materials, followed by sacrificial etching of one metal. The remaining structure consists of individualized high-lateral-aspect-ratio sub-micron metallic films. Example applications of the use of these nanostructures in energy storage and conversion applications, including batteries and magnetic-material-based DC/DC converters, will be discussed.

11:15-11:45 **2A3 Keynote Speaker 8: Hongbo Sun (Watson Auditorium)**

Chair: Hans Zappe & Yao-Joe Yang

(2A3-KS-8) NANO-MICRO-ENGINEERED POLYMERS FOR ADVANCED APPLICATIONS ……No.24

Hong-Bo Sun

State Key Laboratory on Integrated Optoelectronics, College of Electronic Science and Engineering, Jilin University, China

Compared with lithographic and self-assembling nanofabrication technologies, laser nanofabrication features the reasonably high spatial resolution till nanometers, the three-dimensional prototyping capability and eligibility applicable to various materials. In this talk, the recent research progress of the technology will be reported. Particular emphasis will be placed on the works conducted in our lab, such as its use for fabrication of advanced micro-optical, micro-electronic, micro-mechanical, microfluidic, sensing and biomimetic devices and systems.

11:45-13:00 **Conference Lunch (Grand Ball Room)**

13:00-15:00 **Poster and Exhibition 2 (P2): Poster Number 2P1-2P103 EII**

Details of 2P1-2P103 in page 79-98.

15:00-16:30	Session:2B1	Session:2C1	Session:2D1	Session:2E1
Room	F1	M2	M3	EIII
Topic	Micro/nano Sensors, Actuators & Systems 1	Nanobiology, Nano-bio-informatics 1	Cross-Starit Inivted Session 4	Flexible MEMS, Sensors & Printed Electronics 1
Chair &Co-Chair	Kean Aw & Qiangbin Wang	Yu-Cheng Lin & Yi-Kuen Lee	Linsen Chen & Lungjie Yang	Haixiong Ge & Tingrui Pan
Paper ID	407,447,455,481,489,503,515	116,120,429,486,551,442,510	556,107,88,90,411	40(IS-1), 502,131,143,258

15:00-16:30 **Session: 2B1 Micro/nano Sensors, Actuators & Systems 1 Room F1**

Chair&Co-Chair: Kean Aw & Qiangbin Wang

(2B1-1) SILICON CARBIDE CAPACITIVE PRESSURE SENSORS WITH ARRAYED SENSING MEMBRANES …No.407

Bo Meng, Wei Tang, Xuhua Peng, Haixia Zhang

Institute of Microelectronics, Peking University, China

Silicon carbide absolute capacitive pressure sensors with arrayed sensing membranes was designed and fabricated based on silicon-glass anodic bonding. The sensing membranes consist of multiple layers of SiC/Au/SiC, making the device promising to be applied in corrosive environment. The fabricated sensor was integrated with a capacitor read-out circuit in a size of 22 × 23 × 9 mm^3, and then packaged by PDMS, which serves as the coating layer of the electrodes. The packaged sensor remained nearly the same linear response after 60-minutes 30% KOH etching as the one before PDMS packaging, i.e. the sensor with a 5×5 array of 100×100 μm^2 square sensing membranes demonstrates a sensitivity of 0.021 pF/bar over a pressure range from 0.5 bar to 5 bar, and then modified to 0.023pF/bar after KOH etching.

(2B1-2) CLOSE-LOOP SELF-COMPENSATION OF THE COUPLING ERROR FOR SILICON MICROMACHINED GYROSCOPE ……No.447

Jianbin Su, Dingbang Xiao, Xuezhong Wu, Zhihua Chen, Zhanqiang Hou

College of Mechatronics Engineering and Automation, National University of Defense Technology, China

This paper presents the detailed analysis and preliminary design and experiment for close-loop selfcompensation of the coupling error for silicon micromachined gyroscope. A closed-loop feedback control technology is adopted, which uses electrostatic force to counteract the change of coupling stiffness. The electrostatic force is generated by the detection variation of coupling error. Comparing with the openloop detection, the experimental results indicated evidently that the proposed method can effectively decrease the value of the coupling error, increase its stability by 38 times, while the scale factor of the microgyroscope remains unchanged.

(2B1-3) AN OPTIMIZED GEOMETRY MODEL FOR THE MICROMACHINED LIQUID-SUSPENDED ROTOR GYROSCOPE ……No.455

Haifeng Zhang[1,2], Nan Chen[1], Xiaowei Liu[1,2], Xiaoshu Zhang[1], Hai Li[1]
[1]*MEMS Center, Harbin Institute of Technology, Harbin, China*
[2]*Key Laboratory of Micro-systems and Micro-structures Manufacturing (Harbin Institute of Technology), China*

The levitation of the rotor eliminates mechanical friction resulting in high sensitivity for micro-gyroscope, Theoretically. However, the rotor stability is difficult to control due to the rotor's small size. Its performance can not rival vibratory gyroscope at present. In this paper a novel micromachined liquid-suspended rotor micro-gyroscope is proposed, whose stability is improved by liquid suspension. The magnetic field mode of micro-gyroscope is established to analyze the distribution of magnetic field and calculate the driving torque of the rotor. The structure of driving stator is optimized. The flow field model is established to optimize the rotor radius. Using optimized geometry model, the maximum rotational speed of the rotor is 23920rpm.

(2B1-4) PIEZORESISTIVE PROBES FOR (BIOMOLECULAR) FORCE SENSING ……No.481

Joan Bausells, Giordano Tosolini, Yigezu M. Birhane, Francesc Pérez-Murano
Barcelona Microelectronics Institute, IMB-CNM (CSIC), 08193 Bellaterra, Spain

We have developed self-sensing piezoresistive microcantilevers optimized for the measurement of (biomolecular) forces. Typical dimensions are 250 µm in length, 8-20 µm in width and 450 nm in thickness, with spring constants of about 1 mN/m. The devices have been electromechanically tested on wafer and show good force resolutions in air between 35 and 130 pN depending on the cantilever dimensions. We have also tested the electromechanical behavior of the cantilevers in liquid environment and we show that both the force sensitivity and the noise characteristics of the devices are not noticeably degraded as compared with their response in air. This opens the way to the use of the cantilevers in single molecule force spectroscopy of biomolecules.

(2B1-5) ITO NANOWIRES FOR GAS-SENSOR APPLICATIONS ……No.489

M. Afshar[1], E. Preiß[1], T. Sauerwald[2], D. Feili[1], H. Seidel[1]
[1]*Lab of Micromechanics, Microfluidics, and Microactuators, Saarland University, Germany*
[2]*Lab for Measurement Technology, Saarland University, Germany*

In this work we have realized ITO nanowires with typical dimensions of 700 nm width and 200 µm length. They were fabricated by using a novel approach of laser writing in a sputtered indium tin oxide (ITO) film by using a high-repetition rate near-infrared Ti:sapphire laser system based on a 85 MHz, sub-10 fs resonator. These nanowires were characterized electrically and tested as resistive gas sensors with self-heating capability. For this purpose they were exposed to NO_2 concentrations in the ppm range within synthetic air, showing a clear increase of resistance. At ambient temperature the sensor exhibits an integrating behavior with relatively long relaxation times. It was shown that the relaxation times can be shortened by exploiting the self-heating capability of this sensor. The self-heating effect was studied by FEM simulations.

(2B1-6) MOS TUNNELING STRAIN SENSOR USING AN AC MEASUREMENT TECHNIQUE ……No.503

Li Zhu[1], Ruchira Dharmasena[2] and Shamus McNamara[1]
[1]*Dept. of Electrical & Computer Engineering, University of Louisville, Louisville, KY, USA*
[2]*Dept. of Physics, University of Louisville, Louisville, KY, USA*

The increasing requirement for low power sensors is motivating research on new techniques. MOS tunneling sensors consume only nW of power, compared to typical piezoresistive and capacitive sensors which consumes µW to mW. The strain was measured by measuring the tunneling current through a Metal-Oxide-Semiconductor sandwich from a DC voltage. To overcome the electronic noise, substantial averaging was utilized. In this paper an improved method of measuring the strain from the tunneling current is demonstrated in which an AC signal is utilized, and the AC current is measured. This approach substantially reduces the noise by avoiding the 1/f noise. The optimal conditions for the AC technique are to use a high frequency to avoid 1/f noise and a low DC bias.

(2B1-7) MODE LOCALIZATION IN COUPLED AlN/SCS CANTILEVERS FOR HIGHLY SENSITIVE RESONATING FLOWMETER ……No.515

Kenji Kozuka[1], Dong F. Wang[1,2,*], Tsuyoshi Ikehara[2], Keisuke Chatani[1], and Ryutaro Maeda[2]
[1]*Micro Engineering & Micro Systems Laboratory, Ibaraki University (Faculty of Eng.), Hitachi, Ibaraki, Japan*
[2]*Research Center for Ubiquitous MEMS and Micro Engineering (UMEMSME), AIST, Tsukuba, Ibaraki Japan*

The use of vibration mode localization in arrays of mechanically-coupled, nearly identical beam-shaped resonators has been studied for ultra-sensitive mass detection and analyte identification. Our recent work (NEMS 2012) focused on enhancing the amount of amplitude change due to vibration mode localization with a beam shaped 3-resonator array. The preliminarily results were discussed from view point of vibration characteristic by comparing experimental results with analytical ones, without a small mass perturbation. The present study however try to apply the consequent amplitude change to resonating-based flow meter with a simplified system of beam shaped 2-resonator array (AlN/SCS). The possible application has been analytically discussed from view point of vibration characteristic with a small mass perturbation.

15:00-16:30 Session: 2C1 Nanobiology, Nano-bio-informatics 1 Room M2

Chair&Co-Chair: Yu-Cheng Lin & Yi-Kuen Lee

(2C1-1) PROTEIN SCAFFOLDED DISCRETE HYBRID NANOARCHITECTURES ……No.116

Feng Li, Qiangbin Wang
Suzhou Institute of Nano-Tech and Nano-Bionics, Chinese Academy of Sciences, Suzhou, China

Discrete nanoparticle (NP) ensembles have attracted increasing attention because of their distinct properties and potentials in fundamental researches and novel functionalities. For example, discrete gold and silver NP dimers displayed plasmon coupling and functioned as a molecular ruler. Small molecules, DNA, peptides, and polymers have been utilized to assemble one- and two-dimensional nanostructures. Recently, pyramid and tube conformational nanoarchitectures have been constructed by assembling unitary or binary NPs with DNA as scaffold, opening up the possibility of building three-dimensional (3D) NP ensembles. However, the methods suffer from low yields or poor stability or that the particle type and number in a single ensemble cannot be easily tuned. Here we show the controllable assembling of 3D discrete nanoarchitectures of quantum dots (QDs) and gold NPs (AuNPs) with mutated virus-based NPs (VNPs) as scaffolds by simultaneous use of their inside and outside space. QDs are first encapsulated into the icosahedral VNPs. Then AuNPs bind to the outside of the QD-containing VNPs (QD-VNPs) through interactions with rationally introduced semi-exposed cysteines on the VNP surface. By tuning the ratio of AuNPs to QD-VNPs, we have obtained a series of hybrid nanoarchitectures in high yields, in which there is one QD at the center surrounded by a tunable number of AuNPs. Surface plasmon resonance (SPR) coupling of AuNPs and fluorescence quenching of QDs by AuNP clusters were observed in these structures. The findings demonstrate that VNPs can be a robust platform to controllably organize nanomaterials. The diversity in structure and size and the feasibility in structural manipulation of VNPs make this strategy versatile for fabrication of various structures and devices.

(2C1-2) A MATERIAL AND SURFACE MORPHOLOGY INDEPENDENT MICRO ENVIRONMENT "NICHE" FOR TISSUE ENGINEERING ……No.120

C. W. Li[1] and G. J. Wang[1,2,3]
[1]*Ph.D. Program in Tissue Engineering and Regenerative Medicine, National Chung-Hsing University, Taichung, Taiwan*
[2]*Graduate Institute of Biomedical Engineering, National Chung-Hsing University, Taichung, Taiwan*
[3]*Department of Mechanical Engineering, National Chung-Hsing University, Taichung, Taiwan*

In vivo, the cell-cell and cell-ECM interaction contains various niches to regulate organ development. In this study, a micro environment niche, which is independent of material and surface morphology of scaffold, for cell culture is proposed. To define the niche, a micro vibration stage is used to provide precise vibrations on the cell culture device such that the micro shear stress niche between the material and the adhered cells can be estimated. The cultures of bovine endothelial cells (BEC) on three different material culture plates, tissue culture polystyrene (TCPS), poly lactide-co-glycolide (PLGA), and poly lactide acid (PLA), were conducted to illustrate the proposed method. Experimental results demonstrated that the micro shear stresses niche for BEC growth obtained from these three materials are about the same. To further verify the proposed method, the suitable reciprocating frequencies for BEC cultured on a polydimethylsiloxane (PDMS) scaffold was estimated using the conductive shear stress obtained from the original scaffold materials. Proliferation assay further confirmed that the BECs did proliferate well under the calculated reciprocating frequencies. It is hoped that the proposed micro shear stress base niche can be a more cost and time effective solution than the scaffold morphology approaches for the enhancement of cell growth.

(2C1-3) NANOFOCUSED ELECTRIC FIELD FOR LOCALIZED SINGLE CELL NANOELECTROPORATION WITH MEMBRANE REVERSIBILITY ……No.429

Tuhin Subhra Santra, C.Chiu, Nishant Agarwal, Aswin Ganatathi, Pen-Cheng Wang, Fan-Gang Tseng
Institute of Nano Engineering and Microsystems, National TsingHua University, Taiwan
Department of Engineering and System Science, National TsingHua University, Taiwan
Division of Mechanics, Research Center for Applied Sciences, Academia Sinica, Taiwan

Despite the significant research in electroporation, high electric field was applied to the whole cells resulted in permeabilizing the membrane of millions of cells without reversibility [1]. To deliver biomolecules through the specific region of the cell membrane with high cell viability and high transfection rate is important for various biological and therapeutic applications.This report presents a new type localized single cell membrane electroporation (LSCMEP), at specific region of the single cell withthe application of 800 µs electric pulse. The ITO nano-electrodes with 100nm thickness and 500 nm gap between two electrodes can generate an intense electric field to track biomolecules inside HeLa cell in our studies. This small gap between two nano-electrodes can neglect thermal effect on cell membrane and permit reversible electroporation with high cell viability (90%) and minimum effected electroporation region (0.48 µm). Our approach successfully delivers biomolecules through a specific region of single cell with high transfection rate (82%) and high cell viability. This process, not only generates well-controlled nano-pores allowing rapid recovery of cell membrane, but also it provides a clear optical path potentially tracking of drugs to deliver inside single cell.

(2C1-4) QUANTITATIVE ANALYSIS OF DNA METHYLATION BASED ON MELTING CURVE ANALYSIS ……No.486

Pornpat Athamanolap[1], Brian Keeley[2], Dong Jin Shin[1], Tza-Huei Wang[1, 2]
[1]*Department of Biomedical Engineering, Johns Hopkins University, Baltimore, Maryland, USA*
[2]*Department of Mechanical Engineering, Johns Hopkins University, Baltimore, Maryland, USA*

We present a platform to quantify DNA methylation density based on double stranded DNA melting curve profiles. This method combines the approach of traditional melting curve analysis with a bioinformatics supervised learning model to allow quantitative analysis of DNA methylation in a single-tube manner. Furthermore, melting curve analysis can be performed in a microfluidic droplet chip with a custom miniaturized real-time thermocycler. Based on melting profiles, the presence of methylated and unmethylated DNA can be determined by their distinct melting points. In addition, the level of curvature at the peaks of derivative curves can be used to quantify the levels of DNA methylation density, which is unattainable by current gold standard methods such as methylation specific PCR (MSP).

(2C1-5) DYNAMIC SEPARATION OF B-LYMPHOMA CELLS FROM RED BLOOD CELLS USING OPTICALLY-INDUCED ELECTROKINETICS ……No.551

Wenfeng Liang[1,2], Bin Liu[1], Lianqing Liu[1], Zaili Dong[1], Gwo-Bin Lee[1,3], Wen J. Li[1,4], Weijing Zhang[5]
[1]*State Key Laboratory of Robotics, Shenyang Institute of Automation, Chinese Academy of Sciences, Shenyang, China*
[2]*University of the Chinese Academy of Sciences, Beijing, China*
[3]*Department of Power Mechanical Engineering, National Tsing Hua University, Hsinchu, Taiwan*
[4]*Department of Mechanical and Biomedical Engineering, City University of Hong Kong, Kowloon, Hong Kong*
[5]*Department of Lymphoma, Affiliated Hospital of Military Medical Academy of Sciences, Beijing, China*

This study reports an approach to dynamically separate cultured human B-lymphoma (Raji) cells from normal human red blood cells (RBCs), mixed in an isotonic solution, by utilizing a hydrogenated amorphous silicon-based optically-induced electrokinetics chip. A theoretical calculation of the polarization model for the two different types of cells is first presented. The differential velocity between the cell types, generated as a result of the optically-induced dielectrophoresis (ODEP) force is obtained using a finite element method. The theoretical results indicate that the two types of cells could be separated by using the ODEP force. Experimental results verified that the two types of cells can be separated by using two optically projected lines of different widths, with one projected line moving and the other line stationary, as the virtual electrodes for generating the ODEP force. Separation is achieved with these virtual electrodes using a bias potential of 20 Vpp at a driving frequency of 50 kHz. To the best of our knowledge, this work is the first experimental validation of rapid separation of Raji cells from RBCs using optically-induced electrokinetics.

(2C1-6) Al_2O_3/W HETERO-STRUCTURED NANOPORE MEMBRANES:FROM NATIVE TO TUNABLE NANOFLUIDIC DIODES ……No.442

Songmei Wu, Fabien Wildhaber, Arnaud Bertsch, Juergen Brugger and Philippe Renaud
Microsystems laboratory, EPFL STI-IMT-LMIS, Switzerland

We present here Al_2O_3/W hetero-structured nanopore membranes which function as native and electrical field tunable nanofluidic diodes. A typical membrane is 100×100 μm^2 in size with pore density of ~ 20/μm^2. The nanopores are 26nm in diameter and 400 nm in length. Owing to the opposite surface charge states of Al_2O_3 (positive) and W (negative with native oxide), the membrane exhibits clear rectification of ion current in electrolyte solutions. After thermal heating at 350°C for 2 hrs, approximately 10 nm WO_x grows on the surface of W,forming a conformal and dense dielectric layer. The W layer allows the application of an electrical field to further modulate the ionic transport through the nanopores with low gate potentials and ultra low gate leakage current. We have demonstrated the control of rectifying factor from 2 to 11. Our experimental findings have a valuable potential for controllable high throughput molecular separation and chemical processors.

(2C1-7) EFFECTS OF CRYSTAL DEFECTS ON THE ELECTROKINETICS OF NANOFLUIDIC CRYSTAL …No.510

Wei Ouyang[1], Wei Wang[1,2], Haixia Zhang[1,2], Wengang Wu[1,2], Zhihong Li[1,2]
[1]*Institute of Microelectronics, Peking University, China*
[2]*National Key Laboratory of Science and Technology on Micro/Nano Fabrication, Beijing, China*

Nanofluidic crystal (NFC) is attracting research interest as a novel nanofluidic material due to its various advantages over traditional microfabricated nanochannels. Crystal defects form during the self-assembly of NFC. In this work, we investigated the effects of crystal defects on the electrokinetics of NFC in the domain of micrometers (1–100 μm). We found that conductance of NFCs self-assembled in square micropores with lateral lengths of 10–90 μm all demonstrated conductance of a typical nanofluidic nanochannel. However, conductivity degraded dramatically with the increase of micropore sizes. At low concentrations where electrical double layers (EDLs) dominated the conductivity, conductivity dropped to only 20% from 10 to 90 μm micropores.

15:00-16:30 Session: 2D1 Cross-Starit Inivted Session 4 Room M3

Chair&Co-Chair: Linsen Chen & Lungjie Yang

(2D1-1) SYMMETRIC TOGGLE STRUCTURED MEMS LINEAR VARIABLE CAPACITOR WITH LARGE TUNNING RATIO ……No.556

Ling Li, Chenxu Zhao, Mengwei Li, Zewen Liu
Institute of Microelectronics, Tsinghua University, China

A microelectromechanical-system (MEMS) variable capacitor with symmetric toggle structure is proposed to achieve an excellent linearity of the *C-V* response and a large capacitance tuning ratio. Based on lever principle, flexible top plate of the capacitor moves upwards when applying the voltage on the control electrodes increases, which results in a highly linear decrease of the capacitance with increasing control voltage. The proposed MEMS variable capacitor was modeled and simulated using ANSYS software and fabricated using surface micromachining process. The results show a high linearity factor (*LF*) of 96.3% in *C–V* response and a large tuning ratio of 160% in a low actuation voltage range from 0 V to 30 V. The *LF* even reaches 98.9% from 10 V to 30 V.

(2D1-2) STEEL-BASED TAIL ACTUATORS FOR MICRO-AIR-VEHICLES ……No.107

Lung-Jieh Yang, Dung-Lin Jan, Wei-Chung Lin
Department of Mechanical & Electromechanical Engineering, Tamkang University, Taiwan

This work presents an animation of the sporangial motion for making bionic tail flaps of micro-air-vehicles (MAVs) regarding energy saving. A SUS-304 steel foil of 40 μm-thick is used as the substrate and Nd-YAG laser cutting is performed to construct the surface tension-driven actuator. Surface modification including parylene coating and oxygen plasma treatment are tried to enlarge the actuation stroke angle.

(2D1-3) SUB-20nm E-BEAM LITHOGRAPHY TECHNOLOGY ……No.88

Baoqin Chen, Qin Wang
Institute of Microelectronics, Chinese Academy of Sciences, Beijing, 100029, China

In sub-20nm structure graphical electron beam lithography, we adopt a method of the combination of high-resolution, high-contrast electron resists HSQ and Single-line Lithography,implement thinnest 5nm Grid structure lithography. Adopt lattice structure and thin resists preventing phenomenon of adhesion, review and collapse of high aspect-ratio pattern of nano-structure. Adopt spin-coating of the SX AR-PC5000/90.1 conductive protective coating on surface of resists effectively inhibit influence on E-beam lithography from charge accumulation phenomenon of insulator substrates and dielectric films.

(2D1-4) ARRAYED METALLIC MICRO/NANO PARTICLES FOR LOCALIZED SURFACE PLASMON RESONANCE BASED ON METAL CONTACT TRANSFER LITHOGRAPHY ……No.90

C. Y. Wu, H. Y. Chung, and Y. C. Lee
Mechanical Engineering, National Cheng Kung University, Tainan, Taiwan

This paper demonstrates a rapidly, low cost, and mass production process to fabricate arrayed metallic nano-particles on a variety of substrates. A hexagonal arrayed metallic nanoparticles deployed on ITO/glass substrate with sub-micron periodicity is achieved. It is observed in optical transmittance measurements that noble metallic arrayed nano-particles deployed on ITO/glass substrate result in a spectrally narrowband of extinction in visible range, and is in good agreement with the simulated results using finite-element method (FEM). It is found that the narrowband extinction spectrum is associated with electromagnetic field coupling between the arrayed metallic nanostructures and the ITO layer. This electromagnetic field coupling induces significant plasmon resonance in the ITO layer. Based on this observed phenomenon, optoelectronic devices with arrayed metallic nanostructures can be easily designed and developed.

(2D1-5) FABRICATION OF GRAPHENE BASED ELECTROTHERMAL CANTILEVER ACTUATOR ……No.411

Yilong Zhou, Hengchang Bi, Xiao Xie, Litao Sun
SEU-FEI Nano-Pico Center, Key Laboratory of MEMS of Ministry of Education, Southeast University, Nanjing, China

A novel actuator has been fabricated using graphene and graphene oxide composite paper as building blocks. The two materials have nearly equal Young's modulus, however a large displacement was observed during the electromechanically driven operation, which was attributed to great difference in coefficient of thermal expansion of grapheme paper and graphene oxide paper.

15:00-16:30 Session: 2E1 Flexible MEMS, Sensors & Printed Electronics 1 Room EIII

Chair&Co-Chair: Haixiong Ge & Tingrui Pan

(2E1-1-IS-1) OVERVIEW OF FLEXIBLE AND PRINTABLE ELECTRONICS ……No.40

Zheng Cui
Printable Electronics Research Center, Suzhou Institute of Nanotech, Suzhou, China

Flexible and printable electronics represent a paradigm shift in electronics manufacturing, which deviates from mainstream silicon-based microelectronics. Everything has changed, from substrate materials to electronic materials and to the way electronic devices are fabricated, except the basic principle of electronics. This talk gives an overview on what are flexible and printable electronics, why flexible and printable, the principles behind it, the materials and fabrication issues within it, and market potential for this type of electronic products.

(2E1-2) PARYLENE-BASED FOLD-AND-BOND WIRELESS PRESSURE SENSOR ……No.502

Brian Crum, Wen Li
Department of Electrical and Computer Engineering, Michigan State University, USA

This paper describes the design, fabrication, and characterization of a wireless, flexible, passive pressure sensor that is suitable for long-term intraocular pressure monitoring. The integrated planar MEMS coil and the variable capacitor were constructed using a fold-and-bond technique, which avoids multilayer processes and thus reduces fabrication complications. Parylene-C was the structural and packaging material, which ensures the flexibility and biocompatibility of the sensor. Devices were characterized in both air and liquid environments. A pressure sensitivity of 156 kHz/mmHg and a maximum detectable range of 28 mm were achieved in water.

(2E1-3) WEARABLE SKIN SENSOR USING PROGRAMMABLE INTERLOCKING OF NANOFIBERS ……No.131

Kahp-Yang Suh[1, 2], Noo Li Jeon[1, 2], Changhyun Pang[2]
[1]*World Class University Program on Multiscale Mechanical Design,*
[2]*School of Mechanical and Aerospace Engineering, Seoul National University, KOREA*

We presents a highly sensitive, flexible, multiplex strain gauge sensor by utilizing single active layer of nanoscale mechanical interlocking between high aspect-ratio Pt-coated polymeric nanofibers. The sandwich-assembled, interconnected nanofibers supported on thin polydimethylsiloxane (PDMS) layers displayed a specific strain gauge (GF) factors for multiplex sensing such as pressure, shear force, and torsion, measured from the change of electrical resistance as a function of applied compressive strain (≤ 5%). The assembled device was used to monitor continuous kinetic motion of a bouncing micro-droplet on a superhydrophobic surface and physical force of a heartbeat under different conditions. In order to enhance adaptability on exquisite human-skin, skin adhesive patches for in vitro diagnostic device are developed.

(2E1-4) FABRICATION OF TUNABLE WETTING PDMS MEMBRANE BY NANOSTRUCTURING AND PLASMA TREATMENT ……No.143

Xiao-Sheng Zhang[1], Shi-Gan Chu[1], Nicolas Peter[2], Hai-Xia Zhang[1]
[1]*Institute of Microelectronics, Peking University, China*
[2]*Saarland University, Saarbrücken, Germany*

In this paper, we present the tunable wetting behavior of Poly(dimethylsiloxane) (PDMS) by nanostructuring and plasma treatments, which shows stable superhydrophobicity and superhydrophilicity. The PDMS film with high-density nanoporous was prepared by replica molding of the black silicon surface fabricated by an improved deep reactive ion etching (DRIE) process. This simple nanostructuring can increase the roughness and reduce the surface energy of PDMS. The conventional equipment for micro fabrication (i.e. inductively couple plasma etcher) was used to realize plasma treatment to modify the wettability. The effects of different plasma gases on wettability are attributed to physical and chemical mechanisms, which have been investigated by scanning electron microscope (SEM) and energy dispersive X-ray spectroscopy (EDX), respectively. The optimized recipe was obtained after additional chemical analysis. Eventually, the static contact angles of this PDMS membrane remarkably achieved ~160° and ~3°, respectively. Furthermore, the recovery of wettability was reduced by nanostructuring PDMS surface.

(2E1-5) FORMATION AND RELEASE OF MICRO OBJECTS SELF-ASSEMBLED FROM PHOTOCURABLE LIQUID BY MOLDING AND INKJET PRINTING ……No.258

Hsiang-Pi Huang, Tzung-Wei Tsai, Chin-Tai Chen
Mechanical Engineering, National Kaohsiung University of Applied Sciences, Kaohsiung, Taiwan

The microfabrication of versatile small objects can be realized by droplet deposition. The paper presents an improved method for the formation of a photocurable liquid making such micro objects. Micro droplets are inkjet-printed into the micro channels designed and transferred by another 4-inch master wafer. One of key elements in the design involves the use of non-homogeneous substrates to effectively control the complex morphologies of solute deposit during the UV-light curing. The UV-cured liquid formations inside various micro channels are captured and characterized for this droplet formation process. Shapes and morphologies of the structured objects are found to be uniform using hydrophobic PDMS (Polydimethysiloxane).

16:30-18:00	Session:2B2	Session:2C2	Session:2D2	Session:2E2
Room	F1	M2	M3	EIII
Topic	Micro/nano Sensors, Actuators & Systems 2	Micro/Nano Heat Transfer & Energy Harvesters	Cross-Starit Inivted Session 5	Micro/nanofluidics &Bio Chips 1
Chair &Co-Chair	Wibool Piyawattanametha & Tianling Ren	Lishuang Feng & Chenyang Xue	Yu-Lin Wang & Daoheng Sun	Tza-Huei Wang & Yanyi Huang
Paper ID	127,184,198,256,275,305	443,325,330,339,421,424	557,463,555,546	50(IS-2),110,147,167,246,252

16:30-18:00 Session: 2B2 Micro/nano Sensors, Actuators & Systems 2 Room F1

Chair&Co-Chair: Wibool Piyawattanametha & Tianling Ren

(2B2-1) OPTIMIZATION OF SILICON NANOWIRE BASED FIELD-EFFECT PH SENSOR WITH BACK GATE CONTROL ……No.127

Anran Gao, Pengfei Dai, Na Lu, Tie Li, Yuelin Wang
**State Key Laboratories of Transducer Technology & Science and Technology on Micro-system Laboratory, Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences, Shanghai, China*

A FET sensor for pH detection was developed based on CMOS-compatible silicon nanowires. Optical lithography and anisotropic self-stop etching were employed to guarantee low cost and batch production for silicon nanowires. The pH nanosensor can detect the change of the hydrogen ion concentration effectively. In addition, it is demonstrated that the back gate electrode can tune the nanowire detection sensitivity, which can be optimized and exponentially enhanced in the subthreshold regime. The development of a nanoscale sensor with physically engineered gates offers the possibility of highly parallel labeling and detection of chemical and biological molecules with selective control of individual array elements in a single integrated chip.

(2B2-2) MICROMACHINED CATALYTIC COMBUSTION HYDROGEN GAS SENSOR ……No.184

Xifeng Liu[1,2], Hanpeng Dong[1], Shanhong Xia [1]
[1]*State Key Laboratory of Transducer Technology, Institute of Electronics, Chinese Academy of Sciences, Beijing, China*
[2]*Graduate University of Chinese Academy of Sciences, Beijing, China*

A catalytic combustion H2 sensor has been fabricated by using MEMS technology. The application of hafnium oxide thin films as insulating layer has been deposited by electron beam evaporation. The semiconductor combustion catalyst tin oxide (SnO_2) layer was prepared by chemical vapor deposition (CVD).It is a novel application of semiconductor material to catalytic combustion gas sensor. The resistivity of HfO_2 thin film is about $2.4\times10^{12}\Omega\cdot$cm at 900℃. Both the sensing elements and the reference elements could be connected in a suitable circuit such as a Wheatstone configuration with low power consumption. The catalytic combustion sensor shows high response to H_2 at operating voltage of 4V and has a higher relative sensitivity and a good

linearity for the concentrations of H_2 ranging from 0 to 4% in volume. Good consistency and high accuracy of the micro machined catalytic combustion gas sensor were achieved.

(2B2-3) ULTRASENSITIVE MASS DETECTION USING DUAL- MICROCANTILEVERS COUPLED BY CRUCIFORM OVERHANG ……No.198

R. Zhang, G.B. Cai, Z.Q. Wang, L.R. Zhao and W.G. Wu

National Key Laboratory of Science and Technology on Micro/Nano Fabrication, Institute of Microelectonics, Peking University, Beijing 100871, China

We reports the use of dual-microcantilevers coupled by cruciform overhang to enhance the mass sensitivity for minor mass detection. Driven by a piezoactuator in air, each cantilever of the structure can resonate in two different modes (in-phase and out-of-phase modes), and the resonant amplitude-ratios are compared before and after a mass adding. Using this sensing strategy, the cross-shaped overhang of the coupled system, by weakening the coupling effect between 2 cantilevers, provides 2 orders of magnitude enhancement in sensitivity without scaling down the cantilevers.

(2B2-4) FABRICATION AND CHARACTERIZATION OF SURFACE-MODIFIED DRY ELECTRODE FOR MONITORING BI-OPOTENTIAL ……No.256

Yuanfang Chen, Weihua Pei, Sanyuan Chen, Shanshan Zhao, Huan Wang, Qiang Gui, Hongda Chen

State Key Laboratory of Integrated Optoelectronics, Institute of Semiconductors, Chinese Academy of Sciences, Beijing, China

The low and stable contact impedance between the dry electrode and skin interfaces is crucial for the acquisition of high quality biopotential signal, especially for long-term recording. Build-ing upon this fact, poly(3,4-ethylenedioxythiophene) (PEDOT), was introduced onto the surface of dry electrode to increase the active contact area and reduce contact impedance. Silicon-based dry elec-trode (6 mm×6 mm) with pyramid-like micro-needles was fabricat-ed by a low cost method: dicing plus etching. The electrode-to-skin contact impedance (ESCI) measured on subjects proved that dry electrodes with PEDOT surface-modification have better electrical properties than that without PEDOT surface-modification. Besides, PEDOT modification combined with the microfabrication process can provide a rapid, cost-effective and high-yield method to manufac-ture dry electrode.

(2B2-5) A MICROACTUATOR FOR MAGNETIC FIELD CONTROL DEVICE WITH LARGE SHIFTING RANGE ……No.275

Kun Liu[1, 2], Yitong Cao[1], Huaiqiang Yu[1], and Zhihong Li[1]

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[2]*School of Computer and Information Engineering, Peking University Shenzhen Graduate School, Shenzhen, China*

A large tilting angle and zero static power consumption microactuator has been designed and fabricated in order to meet the requirement of low power consumption and remotely control systems. Analytical model and fabrication process flow of rotation actuator have been demonstrated, and static performance has been tested and compared to theoretical data. The results show the performance of our electrostatic driven device in good agreement with theoretical predicted model.

(2B2-6) LOW FREQUENCY ARC-BASED MEMS STRUCTURES FOR VIBRATION ENERGY HARVESTING …No.305

Daniel J. Apo[1], Mohan Sanghadasa[2], and Shashank Priya[1]

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[2]*Aviation and Missile Research, Development, and Engineering Center, US Army RDECOM, Redstone Arsenal, AL, USA*

This study reports the novel arc-based cantilevers for reducing the natural frequency of MEMS cantilever beams without the addition of tip/point mass. The results show an increased potential for energy extraction from naturally occurring vibration sources. An analytical model was used to model the effective mechanical properties of multilayered MEMS cantilevers while the natural frequencies were obtained by applying a finite element code. Results were obtained for two geometries of arc-based cantilevers as well as their linear counterparts. These results demonstrate that arc-based cantilevers vibrate at frequencies significantly lower than their linear components (up to 40% reduction in natural frequency).

16:30-18:00 Session: 2C2 Micro/Nano Heat Transfer & Energy Harvesters Room M2

Chair&Co-Chair: Lishuang Feng & Chenyang Xue

(2C2-1) FLEXIBLE MEMS INDUCTORS BASED ON PARYLENE-FENI COMPOUND SUBSTRATE FOR WIRELESS POWER TRANSMISSION SYSTEM ……No.443

Yang Zheng[1], Xuming Sun[1], Zhongliang Li[1], Xiuhan Li[2], Haixia Zhang[1]

[1]*National Key Laboratory of Science and Technology on Micro/Nano Fabrication, Peking University, Beijing, China*

[2]*School of Electronics and Information Engineering, Beijing Jiaotong University, Beijing, China*

In this paper, flexible MEMS inductors based on Parylene-FeNi Compound Substrate (PFCS) were designed, fabricated and analyzed. We choose parylene as substrate to achieve flexibility and good bio-compatibility. Then, a $Ni_{80}Fe_{20}$ magnetic film was deposited on the parylene film to form a compound substrate. Moreover, a $Ni_{80}Fe_{20}$ core was also deposited in the center of the spiral inductor to improve its performance. As the radius of magnetic core increased from 800um to 1200um, the maximum quality factor and the inductance increased by 288% (from 4.10 to 15.91) and 297% (from 265.94nH to 1.06μH), respectively. If we replaced the magnetic core with magnetic array, the maximum quality factor and the inductance could improve by 111.45% (from 6.29 to 13.30) and 102.78% (from 470.97nH to 955.05nH). Finally, the PFCS inductors were tested in experimental system.

(2C2-2) GOLD NANOPARTICLES DOPED FLEXIBLE PVDF-TRFE ENERGY HARVESTER ……No.325

Dajing Chen[3], Tushar Sharma[3], Yuquan Chen[1], Xin Fu[2], John X.J. Zhang[2,3]

[1]*Department of Biomedical Engineering,* [2]*Department of Mechanical Engineering,Zhejiang University, Hangzhou, China*
[3]*Department of Biomedical Engineering, University of Texas, Austin, USA*
We have successfully developed flexible thin-film energy harvesters based on gold nanoparticles doped PVDFTrFE (polyvinyledenedifluoride–trifluoroethylene) copolymer. The thin film characteristics can be well controlled by the manufacturing process involving the spin-coating and electrochemical deposition. We demonstrate that nanostructures in thin film piezoelectric materials increase the effective area for charge collection, leading towards enhanced power density and reversibility. Such flexible substrate with doped nanoparticles presents a new class of platform for high efficiency, low-cost energy and sensing applications.

(2C2-3) HIGH-Q POLYIMIDE-BASED SPIRAL INDUCTORS WITH MAGNETIC CORE FOR RF TELEMETRY APPLICATIONS ……No.330

Xuming Sun[1], Yang Zheng[1], Zhongliang Li[1], Xiuhan Li[2], Haixia Zhang[1]
[1]*National Key Laboratory of Science and Technology on Micro/Nano Fabrication, Peking University, Beijing 100871, China*
[2]*School of Electronic and Information Engineering, Beijing Jiaotong University, Beijing 100044, China*
This paper presents a new high quality factor (*Q*) and large inductance (*L*) stacked polyimide-based spiral inductor. Polyimide (PI) is used as the substrate and the insulation layer to provide good biocompatibility. To achieve multilayers, selfplanarization of PI on the surface with 10μm steps was realized. Meanwhile, $Ni_{80}Fe_{20}$ was successfully electroplated to enhance the performance of inductors. The double-layer inductor shows a maximum *Q* of 12.7 and a large *L* of 7.078μH at 5.54MHz. Considering the area of the coil, the inductance density is as high as 62nH/mm^2. Based on this inductor, the wireless power transmission (WPT) system was built and tested. The minimum attenuation is -9.4dB at 1.8MHz. With the full IC-compatible fabrication process, this coil could be used in many implantable devices.

(2C2-4) NOVEL 3D NANOHARVESTER BASED ON NANO-ZnO RODS FABRICATED BY ELECTROSPRAY IONIZATION METHOD ……No.339

Z.H. Liu, C.T. Pan, W.C. Wang, C.C. Li
National Sun Yat-Sen University, and Center for Nanoscience & Nanotechnology, National Science Council Core Facilities Laboratory for Nano-Science and Nano-Technology in Kaohsiung-Pingtung area, Kaohsiung, Taiwan
This study presents electrospray process (Fig. 1) with liquid solution epitaxial method to fabricate piezoelectric ZnO (zinc oxide) nanoharvester based on vertically aligned ZnO nanorod arrays, which were packaged beneath the Pt (platinum) coating nanorod arrays, and forming Pt-ZnO schottky rectifying interface.The sol-gel particles were uniformly electrosprayed on Au (aurum)/Si (silicon) substrate, and then formed the pure hexagonal wurtzite crystal structures as ZnO seed layer after annealing treatment at 900 °C for 1 hour (Fig. 2). Well-aligned ZnO nanorod arrays (Diameter: 100-400 nm, Height: 761-1200 nm) of high (002) c-axis preferred orientation with an excellent piezoelectricity were grown at 90 °C for 10 hours using liquid solution epitaxial method (Fig. 3 and 4). Fig. 4(d) shows the EDX spectrum of ZnO nanorods. ZnO nanoharvester was waterproofed using polymer film (Fig. 5), and driving by ultrasonic waves. A continuous DC voltage output (~15mV) is shown in Fig. 6.

(2C2-5) LOW-FREQUENCY VIBRATION-BASED ENERGY HARVESTER USING A PIEZOELECTRIC COMPOSITE BEAM ……No.421

Lokesh Dhakar[1, 2], Huicong Liu[2], F. E. H. Tay[1, 3] and Chengkuo Lee[2]
[1]*NUS Graduate School for Integrative Sciences and Engineering, Singapore*
[2]*Department of Electrical and Computer Engineering, National University of Singapore, Singapore*
[3]*Department of Mechanical Engineering, National University of Singapore, Singapore*
A composite beam based piezoelectric energy harvester (EH) is designed and characterized which can be used to harvest energy with low frequency vibrations. This kind of EH is demonstrated to be 3.12 times and 1.32 times (at 0.1g) more efficient at output power generation than a standalone piezoelectric bimorph and piezoelectric bimorph with a proof mass at the free end, respectively. The resonant frequency of the EH is reduced from 275 Hz (for standalone bimorph) to 36 Hz by using the soft spring. With the aid of spring hardening effect using a stopper, the operating bandwidth is increased from 5.25 Hz to 16.4 Hz.

(2C2-6) IMPACT BASED FREQUENCY INCREASED PIEZOELECTRIC VIBRATION ENERGY HARVESTER FOR HUMAN MOTION RELATED ENVIRONMENTS ……No.424

Miah A. Halim, Sungwon Khym, Jae Y. Park
Micro/Nano Devices and Packaging Lab, Department of Electronic Engineering, Kwangwoon University, Seoul, 139-701, Korea
This paper presents a frequency increased piezoelectric vibration energy harvesting device where the low frequency periodic impact of a driving beam with a horizontally extended rectangular tip makes two piezoelectric generating beams to vibrate at the same time, with their higher resonant frequencies, producing higher power output. The dimension of the flexible driving beam was 58×4.8×1 mm^3 and that of each piezoelectric generating beam with styrene support was 15×3.5×0.8 mm^3. Each generating beam of the proposed energy harvester produced a maximum peak output power of 46.51 μW across an optimum resistive load of 200 KΩ under 4 ms^{-2} acceleration and was increased up to 129.15 μW while the acceleration was increased up to 6 ms-2 at an operating frequency of 12.5 Hz. The output of both generating beams with series connection doubled the overall output of the device.

16:30-18:10 Session: 2D2 Cross-Starit Inivted Session 5 Room M3

Chair&Co-Chair: Yu-Lin Wang & Daoheng Sun

(2D2-1) ELECTRICAL-MECHANICAL COUPLING IN BENT ZnO NANO/MICROWIRES ……No.557

Xuewen Fu[1], Xiaobing Han[1], Ziyue Zhang[2], Zhuhua Zhang[2], Xinli Zhu[1], Rui Zhu[1], Jun Xu[1], Wanlin Guo[2] and Dapeng Yu[1]

[1]*State Key Laboratory for Mesoscopic Physics, Department of Physics, 209 Chengfu Road, Peking University, Beijing 100871, China*
[2]*State Key Laboratory for Mechanics and Control of Mechanical Structures, and MOE Key Laboratory of Intelligent Nano Materials and Devices, Institute of Nano Science, Nanjing University of Aeronautics and Astronautics, 29 Yudao Street, Nanjing 210016, China*
High special/energy resolution cathodoluminescence (CL) spectroscopy enables us to make precise investigation on the optical/electronic fine structures in nanostructures. we report a significant strain-gradient effect on energy band-gap in bent ZnO microwires with diameter of 0.3~2.5 μm. Strain-gradient breaks the symmetry of local strain effect on energy bands as shown in uniform strained ZnO. The linear distribution of strain gradient from tensile to compression in bent ZnO nano/microwires provides ideal conditions to address the modification of the electronic structures by strain in semiconductor materials. Radial line scan of the CL spectroscopy along bent ZnO wires at liquid helium temperature shows very fines excitonic emission structures, which demonstrates systematic red shift towards the increase of tensile strain, and blue shift as well as excitonic peak splitting towards the increase of compressive strain. Strain-gradient is found to dominate the overall red-shift of the emission energy at a pure bending configuration.

(2D2-2) ELECTRIC-FIELD-DRIVEN NANOSCALE ELECTROMAGNETIC ACTUATING ……No.463
Tien-Kan Chung
Department of Mechanical Engineering, National Chiao Tung University, Hsinchu 30010, Taiwan
In this paper, we report an electric-field-driven nanoscale electromagnetic actuating. The device consists of a lithography-patterned Ni-nanobars on top of a piezoelectric Lead-Zirconate-Titanate (PZT) thin film deposited on a silicon wafer. When an electric field is applied to the PZT film, in-plane strains in the film are developed through the piezoelectric actuation. Due to the mechanical coupling between the PZT-film and Ni-nanobars, the strains are transmitted to the Ni-nanobars. Through the magnetostriction, the strains transform the magnetic single-domain of each Ni-nanobar. This achieves an electric-field-driven magnetic-domain transformation (magnetization rotation) in the Ni-nanobar. That is, nanoscale electromagnetic actuating.

(2D2-3) MICRO/NANO BUBBLES FOR MEDICAL THERANOSTICS ……No.555
Xiao-bo Ruan[1], Fang Yang[1], Yu Zhang[1], Ning Gu[1,2]
[1]*State key laboratory of Bioelectronics, Jiangsu Laboratory for Biomaterials and Devices, Southeast University, Nanjing, China*
[2]*Suzhou Key Laboratory of Biomedical Materials and Technology, Suzhou Institute of Southeast University, Suzhou, 215123, China*
One of the great promises of clinical practice is personalized medicine, which need genetic testing and better individualize care. With the conception of theranostics, we can improve the current paradigm and the related tools to this direction. Microbubbles, miniature gas bubbles with a range of sizes, could be found very useful in several areas, such as imaging enhancement and drug delivery. Herein our work on the fabrication of microbubbles with shell-embedded and surface-assembled superparamagnetic nanoparticles, called magnetic microbubbles, has been presented. To be a theranostic device, this micro-nano-complex has been shown its potential applications as the contrast agent for dual enhancement of magnetic resonance imaging (MRI) & ultrasound image (US). Micro-containers changed into bubble micro-reactors acts as the remote controlled carriers for the release of encapsulated drugs. What's more, the fabrication of micro-nano-liposomal bubbles with a new method by a Gas-liquid mixing device is under studying.

(2D2-4) USING CELLULAR ARCHITECTURE TO PREPARE NANOMATERIALS AND NANOSTRUCTURES …No.546
Chao-Min Cheng
Institute of Nanoengineering and Microsystems, National Tsing Hua University, Hsinchu 300, Taiwan
Humankind often derives guidance and inspiration from the nature, which exhibits diverse structures that enable organisms to accomplish complex functions using highly integrated and optimized solutions. However, most designers originate without any explicit reference to nature, as direct natural analogs do not exist for many associated technological applications. In recent years, there has been increasing interest in borrowing design concepts or inherent materials from nature to create the functional materials, structures, and systems at the small scale. I will i) outline, and ii) provide my own perspectives on how to make functional nanomaterials and nanostructures (in advance, nanosystems) through using biologically relevant elements such as actin filaments or microtubules (i.e., cellular structural elements), based on interests that have been significantly generated in multiple academic communities including nanomaterials (materials science), nanotechnology (engineering, applied physics) as well as biotechnology (cell biology, bioengineering). For example, the bottom-up approach of growing and assembling inorganic structures that have biological relevance has received much attention. While this assembly is important, the ability to position these materials at the defined locations would introduce additional control for a diversity of applications. The use of printing methods has enabled the ability to create spatially regular patterns on surfaces with large areas. Combining the assembly of actin filaments and printing of structures to create small-scale rods though a simple and reproducible method would provide a new degree of freedom in studying many processes. Herein, I will first present a novel printing method to influence the polymerization of G-actin *in vitro* by applying a pressure (mechanical force) on the upper surface of a fabricated stamp to regulate the dewetting process of an inorganic buffer. This process is implemented while also controlling the evaporation rate of the solvent between the substrate and surface of the stamp. This enables the polymerization of filamentous-based nanorods which could be controlled at specific locations and with reproducible patterns. I will then introduce the control of molecular filament organization through biologically-inspired intermediates, enabling us to obtain large-area regular nanopatterns. We have studied cultured single filamentous actins on an unmodified glass surface (hydrophilic surface) and introduced myosin-II to modify the control. We then have utilized an inorganic salt crystallization approach on the response of these two proteins, actin filament and myosin-II, to analyze the resultant spatially localized patterns. Through the utilization of myosin-II and the salt crystallization approach, we are able to induce the filament orientation of 63° ; while without myosin-II, we induce an orientation of 90.

16:30-18:00 Session: 2E2 Micro/nanofluidics &Bio Chips 1 Room EIII

Chair&Co-Chair: Tza-Huei Wang & Yanyi Huang

(2E2-1-IS-2) DECIPHERING THE DYNAMIC LIFE OF SINGLE CELLS THROUGH MICROFLUIDIC-ASSISTED MICROSCOPY AND TRANSCRIPTOME ANALYSIS ……No.50

Yanyi Huang
College of Engineering, and Biodynamic Optical Imaging Center (BIOPIC), Peking University, Beijing, China
Microfluidic platforms enable quantitative analysis of biological systems which can not otherwise be executed in a traditional bench top setting [1]. Progress in quantitative image analysis has also evolved microscopy into a powerful tool for systems biology studies as automated image collection and analysis techniques are able to quantitatively process three-dimensional image data with more and more detail. Here we present a microfluidic platform for label-free cellular imaging and sorting with stimulated Raman scattering (SRS) microscopy. SRS microscopy is a quantitative technique which achieves label-free imaging with chemical specificity and low background by exploiting vibrational resonances in chemical bonds [2]. Microfluidic technology enables precise and dynamic handling of nanoliter volumes of liquid and provides an ideal platform for single-cell processing. A SRS microscope is integrated with a microfluidic device which can manipulate, trap and sort single cells. After sorting, single cells are prepared for gene expression analysis. This system is used to characterize lipid metabolism by quantifying intercellular lipid droplet morphology and gene expression and demonstrates the potential for a systems approach to studying lipid droplet biology.

(2E2-2) DYNAMIC BEHAVIORS OF MICRODROPLETS IN CONVERGENT MICROCHANNELS UNDER THE EFFECT OF DIELECTROPHORESIS ……No.110

Y. Yan, D.Guo, S.Z.Wen
State Key lab of Tribology, Tsinghua University, Beijing, China
The convergent microchannel is widely applied to connect microchannels with different sizes to avoid sharp changes of the flow field. It is important to investigate the dynamic properties in the convergent microchannel to promote the development of microdevices. Numerical simulation method is used to study the dynamic behaviors of microdroplets in a convergent microchannel. The microchannel is embedded with electrodes and alternating current (AC) is applied on the electrodes. Under the effect of nonuniform electric field,dielectrophoresis force is defined as the driving force to manipulate the microdroplets in the convergent microchannel. In this study, the surface tension is considered in the Navier-Stokes equations. The influence of dielectric constant and magnitude of voltage on the dynamic behaviors of microdroplets are analyzed in details. According to the results, the velocity of the microdroplet is proportional to the dielectric constant and voltage in the convergent microchannel. This can provide an efficient method to control the droplet merging process during the biological or chemical experiments.

(2E2-3) A NEW MICROPUMP USING AMPLIFIED DEFORMATION OF RESILIENT MEMBRANES ……No.147

Chung-Hsien Liu and Gwo-Bin Lee
Department of Power Mechanical Engineering, National Tsing Hua University, Hsinchu, Taiwan
This study presents a new, pneumatically-driven micropump made of PDMS (polydimethylsiloxane) membranes for liquid delivery. Liquid samples can be transported by using a new mechanism generated by three oil-hydraulic chambers, which were first filled with liquid (mineral oil) and then deformed by compressed air such that an amplified deformation of the PDMS membranes can be generated for liquid transportation. Experimental results showed that the new mechanism could be used to amplify the deformation of membranes and generate considerable pumping rates. It could be promising for automation of microfluidic devices and systems.

(2E2-4) MONITORING THE DISEASE ACTIVITY VIA THE ANTIBODY-ANTIGEN RECOGNITION IN PAPER ……No.167

Hsi-Kai Wang[1,2], Cheng-Han Tsai[1,3], Chung-Tao Tang[2,4], Pi-Chun Li[2], Jiun-Shyang Leou[2], Yin-Liang Tang[2,4], Hsyue-Jen Hsieh[3], Han-Chung Wu[2], Chao-Min Cheng[1,2]
[1]*Institute of Nanoengineering and Microsystems, National Tsing Hua University, Hsinchu 300, Taiwan*
[2]*Institute of Cellular and Organismic Biology, Academia Sinica, Taipei 128, Taiwan*
[3]*Department of Chemical Engineering, National Taiwan University, Taipei 106, Taiwan*
[4]*Graduate Institute of Life Sciences, National Defense Medical Center, Taipei 114, Taiwan*
Dengue fever is one of the acute flavivirus-borne infectious diseases caused by dengue virus with four serotypes. To date, there are no efficient diagnostic tools available for monitoring the disease activity of dengue fever. It is needed to develop a diagnostic device with the characteristics of inexpensiveness, ease-to-use and robustness for the detection of dengue fever. In this study, we have developed an ELISA-based diagnostic device prepared via wax printing method through using filter paper. The antigens that we targeted to quantify in the buffer system were both non-structural protein 1 with the detection limit of about 100 pg/mL and envelope protein with the diluted virus culture soup of about 100 times of serotype 2 dengue virus (only 2 μL sample). We believe that this study would provide insight on the development of *in-vitro* diagnostic devices for dengue fever and various diseases in the different divisions of medicine.

(2E2-5) IN-PARALLEL RARE CELLS IDENTIFICATION BY HIGH THROUGHPUT CELLS SELF-ASSEMBLY ……No.246

Jui-Chia Chang, Tsung-Ju Chen, Yu-Cheng Chang, and Fan-Gang Tseng
National Tsing Hua University, Taiwan
In this study, we present a high density cells self-assembly chip to form a dense monolayer cell array by the employment of gravity force and fluidic force. The cancer cells can be identified in mega primary lymphocytes at the single cell level by immunofluorescence. This chip is compatible with standard fluorescence microscopy equipment and possible to do cell culture after cell array formed.

(2E2-6) A COMPACT DISK (CD) MICROFLUIDIC PLATFORM FOR RAPID SEPARATION AND MIXING OF BLOOD PLASMA ……No.252

Bo-Shiun Li and Ju-Nan Kuo
Department of Automation Engineering, National Formosa University, Yunlin, Taiwan
This paper presents a new lab-on-CD microstructure capable of directly separating plasma from the whole blood into different reservoirs and performing plasma mixing functions. We propose a CD microfluidic platform, including a microchannel network consisting of a plasma separation microchannel network and a mixer microchannel network. As the disk rotates, the centrifugal force causes the separation of blood cells and plasma because of their different densities. The blood cells enter a collection chamber, while the plasma flows to the downstream mixer microchannel network. Numerical simulations are performed to investigate the flow characteristics and mixing performance of three CD microfluidic mixers. The results show that given an appropriate specification of the microchannel geometry and a CD rotation speed of 1800 rpm, 90% separation efficiency is achieved for diluted blood with a hematocrit of 6%, and a mixing efficiency of more than 92% can be obtained within 3 s at an angular frequency of 2000 rpm.

18:30-21:00 **Banquet (Grand Ball Room)**

Day3: Wednesday, April 10, 2013

8:30-9:15

3A1 Plenary Speaker 3: Prof. Zhonglin Wang (Watson Auditorium)

Chair: Ning Xi

(3A1-PS-3) NANOGENERATORS AND PIEZOTRONICS - FROM BASIC SCIENCE TO NOVEL APPLICATIONS …No.3

Zhong-Lin Wang[1,2]
[1]*School of Materials Science and Engineering, Georgia Institute of Technology,USA*
[2]*Beijing Institute of Nanoenergy and Nanosystems, Chinese Academy of Sciences, China*
Developing wireless nanodevices and nanosystems is of critical importance for sensing, medical science, environmental/infrastructure monitoring, defense technology and even personal electronics. It is highly desirable for wireless devices to be self-powered without using battery. We have developed nanogenerators based on piezoelectric, trioboelectric and pyroelectric effect,aiming at seeking self-sufficient power sources for mico/nano-systems. The output of the nanogenerators is now high enough to drive a wireless sensor system and charge a battery for a cell phone. For Wurtzite structures that have non-central symmetry, such as ZnO, GaN and InN, a piezoelectric potential *(piezopotential)* is created in the crystal by applying a strain. Such piezopotential can serve as a "gate" voltage that can effectively tune/control the charge transport across an interface/junction; electronics fabricated based on such a mechanism is coined as *piezotronics*, with applications in force/pressure triggered/controlled electronic devices, sensors,logic units and memory. By using the piezotronic effect, we show that the optoelectronc devicesfabricated using wurtzite materials can have superior performance as solar cell, photon detectorand light emitting diode. Piezotronics is likely to serve as a "mechanosensation" for directly interfacing biomechanical action with silicon based technology and active flexible electronics.This lecture will focus on the fundamental science and novel applications of nanogenerators and piezotronics.

9:15-10:15

3A2 Keynote Speaker 9: Taesong Kim (Watson Auditorium)

Chair: Wen J. Li & Kukjin Chun

(3A2--KS-9) MOLECULAR BASED DETECTION USING PIEZOELECTRIC THIN FILM COATED MICROCANTILEVER ……No.28

Kyo Seon Hwang[1], Jeong Hoon Lee[2], Sang Kyung Kim[1], Ji Yoon Kang[1], Tae Song Kim[1]
[1]*Center for BioMicrosystems, Korea Institute of Science and Technology (KIST), Seoul, Korea*
[2]*Department of Electrical Engineering, Kwangwoon Univ., Seoul, Korea*
We have developed piezoelectric thin film layer-embedded microcantilever which is able to quickly convert between mechanical vibration and electrical charge inducing for the application to biological substance detection with high measuring performance. These piezoelectric driven microcantilevers provided the application feasibility in a nanomechanical point-of-care diagnosis by enabling electrical measurement of sensor's response signal because it did not have to use bulky optical system. In our earlier researches, the fabricated piezoelectric cantilevers by surface and bulk micromachining process utilized as excellent platform for biomolecules detection such as disease related proteins [1, 2], DNA with specific sequence [3], enzyme [4]. Recently, we have tried to expand the application field in addition to biomolecule detection in liquid sample. Here, in this presentation, we are going to introduce and propose our new approaches to several application using piezoelectric driven microcantilevers.

3A2 Keynote Speaker 10: Gwobin Lee (Watson Auditorium)

Chair: Wen J. Li & Kukjin Chun

(3A2--KS-10) OPTICALLY-INDUCED DIELECTROPHORESIS (ODEP) ON MICROFLUIDIC SYSTEMS FOR BBIOMEDICAL/NANOTECHNOLOGY APPLICATIONS ……No.23

Gwo-Bin(Vincent) Lee
Department of Power Mechanical Engineering, Institute of Biomedical Engineering, Institute of NanoEngineering and Microsystems, National Tsing Hua University, Hsinchu, Taiwan
In recent years, optically-induced dielectrophoresis (ODEP) has been recognized as a promising technique to manipulate micro- and nano-particles and cells in biomedical applications. The traditional complicated fabrication of micro-electrodes to generate the dielectrophoresis (DEP) force can be substituted by using "virtual" electrodes defined by a projected light beam. With the ability to catch and control a single cell or particle by using

appropriate optical patterns, ODEP has been developed as an enabling technique particularly in the manipulation, separation, collection, alignment, transportation and characterization of cells/particles. In this talk, I will present several examples using ODEP on microfluidic systems for biomedical and nanotechnology applications, including micro flow cytometer, micro separator, cell lysis, cell rotation, DNA stretching and CNT alignment.

10:15-10:45 **Coffee Break and Exhibition**

10:45-11:15 **3A3 Keynote Speaker 11: Xinxin Li (Watson Auditorium)**

Chair: Fangang Tseng & Lining Sun

(3A3-KS-11) EFFORTS ON THE TWO INTERFACES OF RESONANT-CANTILEVER FOR ULTRA-SENSITIVE BIO/CHEMICAL SENSING ……No.30

Xinxin Li

State Key Lab of Transducer Technology, Shanghai Institute of Microsystem and Information Technology, CAS, Shanghai, China

Different from MEMS physical sensors like pressure sensor and accelerometers, which have been well commercialized and widely applied, bio/chemical micro/nano sensors are still under technical development. Bio/chemical sensors enclose two interfaces for molecule recognition and signal transduction, respectively. In order to distinguish the two interfaces for improved specific selectivity and signal sensitivity. We will focus on the point and give lots of our research examples that employ micro/nano combined resonant cantilevers as bio/chemical sensing platform for on-the-spot trace-level detection.

11:15-11:45 **3A3 Keynote Speaker 12: Jianxin Wu (Watson Auditorium)**

Chair: Fangang Tseng & Lining Sun

(3A3-KS-12) SUZHOU INDUSTRY PARK OVERVIEW AND NANOPOLIS SUZHOU ……No.32

Jianxin Wu

Suzhou Nanotech Co., Ltd. China

Suzhou Industrial Park (SIP), which is the largest cooperation project between China and Singapore, has developed to be a new city. The project started from 1994 and now SIP is the home to over 20,000 national and multinational companies, with a strong industry base in IC, TFT-LCD, high-end equipment, telecommunication, bio-pharmaceutical, etc. and probably the highest density of venture capitals in the world, with more than 100 VCs and PE funds. For the further development and upgrade of the current industry, SIP will focus on the nanotech and reframe itself as Suzhou Innovation Park (SIP). Nanotech industry areas of focus include Nano Material, Micro/Nano-Manufacturing, Energy & Green Tech and Nano biotech. Suzhou's focus on nanotech innovation & commercialization follows naturally from its strengths in industry, business and commercialization partners. By the end of 2012, SIP has attracted over 5500 nanotech related experts, entrepreneurs and engineers among 100+ nanotech companies and 20+ institutes and universities. Now SIP is well on its way to being the most global and innovative nanotech hub in China, and intends to attract over 200 nanotech companies from all over the world and 10,000 nanotech experts within the next 3 years. SIP is actively building up whole ecosystems and value chains, so you can easily and rapidly take your nanotechnology or idea from R&D to prototyping, to commercialization. Ecosystem elements, including the Nanotech Startups, traditional companies, research institutes and universities, Venture Capitals, are strongly encouraged and supported to cooperate together to speed up the nanotech innovation, commercialization and application, under the government support and cluster cultivation.

11:45-13:00 **Conference Lunch (Grand Ball Room)**

13:00-14:30

	Session:3B1	Session:3C1	Session:3D1	Session:3E1
Room	F1	M2	M3	EIII
Topic	Nanomedicine	Nanobiology, Nano-bio-informatics 2	Cross-Starit Inivted Session 6	Micro/nanofluidics&Bio Chips 2
Chair &Co-Chair	Litao Sun & Wen Li	Xianting Ding & Che-Hsin Lin	Yenwen Lu & Wenhao Huang	Ting Zhang & Junbo Wang
Paper ID	548(IS-3),370,190,319	148,369,474,507,401	176,245,182,435,194	204(IS-4), 277,294,332,387

13:00-14:30 **Session: 3B1 Nanomedicine Room F1**

Chair&Co-Chair: Litao Sun & Wen Li

(3B1-1-IS-3) INTEGRATING APTAMERS AND MICROFLUIDICS FOR BIOLOGICAL MANIPULATION AND SENSING ……No.548

Qiao Lin[1], Jinho Kim[1], Jing Zhu[1], J. Yang[1], John Hilton[1], ThaiHuu Nguyen[1], Renjun Pei[2], Kyung-Ae Yang[2], Milan Stojanovic[2]

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We present an overview of our efforts to integrate aptamers and microfluidic devices, including manipulation of biomolecules and cells using aptamers, and isolation of targetbinding nucleic acids. The aptamer-based devices for target manipulation are capable of specific analyte extraction and enrichment as well as isocratic elution, and can be coupled to biodetection systems for highly sensitive analyte detection. The microfluidic devices for isolation of target-binding nucleic acids demonstrate the potential for integrated selection of aptamers having predefined binding characteristics against a broad spectrum of practically important biological analytes.

(3B1-2) THE NEW ANTICANCER AGENT PTX-MNPS INDUCED CELL CYCLE ARREST AND APOPTOSIS IN MULTIPLE MYELOMA CELLS IN VITRO ……No.370

Cuiping Yang[1,2], Fei Xiong[3], Yu Zhang[3], Ning Gu[3], Jun Dou[1]
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[3]*School of Biological Science & Medical Engineering, Southeast University, Nanjing, China*

Although new therapies have increased the survival of multiple myeloma (MM) patients, the disease remains incurable. Recurrence of MM after therapy suggests that it has been postulated that $CD138^-$ $CD34^-$ cells called cancer stem cells (CSCs) that would be responsible for tumor initiation and relapse. An effective drug targeted $CD138^-$ $CD34^-$ MM CSCs need to be developed. This study aimed to investigate an inhibitory effect of anticancer agent paclitaxel Fe_3O_4 magnetic nanoparticles (PTX-MNPs) on $CD138^-$ $CD34^-$ MM CSCs. $CD138^-$ $CD34^-$ cells were isolated from NCI-H_929 MM cell line by immune magnetic bead sorting method and then exposed with the MNPs (0.1μg/μl), PTX (0.6μg/μl) and PTX-MNPs (0.08μg/μl) for 24 hours. The cell viability, apoptosis and caspases expression were respectively valuated. The isolated $CD138^-$ $CD34^-$ cells possess the characteristic of CSCs. PTX-MNPs significantly inhibited CSC proliferation and increased expressions of caspases and resulted in CSC apoptosis. These data demonstrate PTX-MNPs as a promising anticancer agent that may contribute to future targeting therapy of MM CSCs for clinical trials.

(3B1-3) BEND WAVEGUIDE WITH BROAD BANDWIDTH AND HIGH TRANSMISSION EFFICIENCY BASED ON AIR-HOLE PHOTONIC CRYSTAL ……No.190

Xiaoyuan Ren[1,2], Lishuang Feng, Zhili Lin
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[2]*Laboratory of Micro-nano Measurement-Manipulation and Physics, Beihang University, Beijing, 100191, China*

Photonic crystals (PCs) have been investigated for more than 20 years since its conception was proposed. In this work, we established a novel structure of the bend waveguide which is composed of photonic crystal (PC) with triangular lattice of air-holes. By optimizing the bend structures, not only the transmission bandwidth of the whole waveguide is greatly improved, but also the transmission efficiency is enhanced. The transmission efficiencies of the wavelengths between 1504nm and 1586nm can reach more than 80%. The highest transmission efficiency 95% can be obtained for the wavelength of 1553nm. By simulating the transmission of the optimized bend waveguide, the light wave whose wavelength is 1553nm can propagate effectively.

(3B1-4) OBSERVATION OF STRONG TRANSVERSE MAGNETO-OPTICAL KERR EFFECT ON SURFACE PLASMONIC GRATINGS ……No.319

N. P. Ling[1], K. H. Chou[1], C. T. Jhou[1], M. H. Lai[1], T. C. Chen[1], C. H. Lai[2], L. W. Wang[2], G. B. Lee[3],and M. C. M. Lee[1]
[1]*Institute of Photonics Technologies, National Tsing Hua University, Hsinchu, Taiwan*
[2]*Department of Materials Science and Engineering, National Tsing Hua University, Hsinchu, Taiwan*
[3]*Department of Power Mechanical Engineering, National Tsing Hua University, Hsinchu, Taiwan*

Strong transverse magneto-optical Kerr effect (TMOKE) on Au/Fe/Au surface plasmon (SP) gratings is demonstrated. Via the optimal design of this structure, the measured Kerr parameter is 0.03, which is 3 times larger than the maximal value ever reported on a plane magneto-optical SP substrate. Moreover, the Kerr parameter is very dispersive near the SP wavelength, which can be used for a high sensitive biosensor.

13:00-14:30 Session: 3C1 Nanobiology, Nano-bio-informatics 2 Room M2

Chair&Co-Chair: Xianting Ding & Che-Hsin Lin

(3C1-1) A NEW CARBON NANOTUBE-BASED HOT-FILM SENSOR ASSEMBLED BY OPTICALLY-INDUCED DIELECTROPHORESIS ……No.148

Ming-Chang Hsu and Gwo-Bin Lee*
Department of Power Mechanical Engineering, National Tsing Hua University, Hsinchu, Taiwan

Miniaturized sensors have been demonstrated by micromachining technology since late 1980s. Recently, carbon-nanotubes (CNTs) have been extensively explored for a variety of applications since they have unique electrical and exceptional mechanical properties, which may be excellent candidate for nano-sensors. Conductors or semiconductors can be formed with different length and diameters of CNT, multi-walled carbon nanotubes (MWCNTs) and single-walled carbon nanotubes (SWCMTs). Optically-induced dielectrophoresis (ODEP) technique has been demonstrated to manipulate microparticles by illuminating optical patterns on a photoconductive material. The ODEP chip was formed with indium-tin-oxide (ITO) and photoconductive amorphous silicon (a-Si). When the light was illuminated on a-Si, it could produce non-uniform electric field and generate ODEP force. In this study, CNTs were collected between two gold electrodes by ODEP force. The pre-assembled CNTs line was further immobilized by illuminated ultraviolet light. Then, the cured polymer was ashed by the oxygen plasma. After aligning CNTs between Au electrodes, the CNTs line can be used for sensing air flow velocities while operated at a constant-current mode. A CNT-based hot-film sensor was therefore successfully demonstrated in this study. This technique can be easily extended for mass-production of CNT-based hot-film sensors by using the capability of ODEP platform.

(3C1-2) ROBOTIC NANOWIRE HANDLING FOR PROTOTYPIC NEMS SWITCHING AND RESONATOR DEVICES ……No.369

Malte Bartenwerfer and Sergej Fatikow
Division Microrobotics and Control Engineering, Department of Computing Science, University of Oldenburg, Oldenburg, Germany

In this paper the usage of a nanorobotic handling technique is presented for the transfer of individual nanowires with diameters of several 100 nanometers and length of about 10 µm. Both, handling and assembly take place inside a SEM and use electron beam induced deposition (EBiD) as well

as focused ion beam (FIB) milling. The handled nanowires are used to assembly a NEMS device, namely an electrostatic switch design and a resonator, where the nanowire acts as switching contact and resonant component, respectively. Feasibility, working principle, reproducibility and specific values of the switches are investigated, as well as the conductivity of the nanowires itself.

(3C1-3) UNDERCUT EDGES FOR ROBUST CAPILLARY SELF-ALIGNMENT IN HYBRID MICROASSEMBLY ..No.474

Ville Liimatainen, Veikko Sariola and Quan Zhou
Department of Automation and Systems Technology, School of Electrical Engineering, Aalto University, Finland

In this paper, we report capillary self-alignment of 200 µm × 200 µm square parts on matching patterns with undercut edges. The undercut edge structure is a purely topographical feature that provides ultimate pinning for liquids of any surface tension without chemical treatment. We show contact angles close to 180° for low surface tension liquids, and capillary self-alignment using thermally curable adhesive. Sub-micron alignment accuracy after adhesive curing is verified in a scanning electron microscope (SEM).

(3C1-4) MULTI-SPECTRAL CONFOCAL IMAGING PROBE ……No.507

Pongsak Sarapukdee[1], Santi Rattanavarin[2], Numfon Khemthongcharoen[2], Ungkarn Jarujareet[2], Romuald Jolivot[2], Il Woong Jung[3], Daniel López[3], Michael J. Mandella[4], and Wibool Piyawattanametha[1,2]
[1]*Advanced Imaging Research Center, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand*
[2]*National Electronics and Computer Center, Pathumthani, Thailand*
[3]*Center for Nanoscale Materials, Argonne National Laboratory, Argonne, Illinois, USA*
[4]*James H. Clark Center for Biomedical Engineering & Sciences, Stanford, California, United States*

We developed a novel MEMS based handheld multi-spectral confocal microscope providing the maximum tissue imaging depth of 400 µm, 6 µm transverse resolution, and the maximum speed of image collection up to 10 Hz with 200×200 image pixel size. Biological imaging performance was demonstrated on mouse ears and tissues of human cervix. 3D rendered images from our system is able to reveal the mouse ear blood vessels and nuclei of epithelial cells in cervical tissue samples.

(3C1-5) MICRO PROCESS ENGINEERING OF FREESTANDING SILICON FLUIDIC CHANNELS WITH INTEGRATED PLATINUM THERMISTORS FOR OBTAINING HEAT TRANSFER CORRELATIONS ……No.401

R. Roth, K. Cobry, G. Lenk, P. Woias
Laboratory for the Design of Microsystems, IMTEK, University of Freiburg, Germany

The heat transfer in silicon microchannels with integrated in-line and staggered pin fin arrays is evaluated at clearance-to-diameter ratios of 0.5 - 0.77 in the laminar flow regime. The channels have a small width, leading to a significant influence of the channel walls on fluid flow and heat transfer. Their influence is considered when measuring the temperature distribution along the channel length and the average heat transfer. For this purpose platinum thermistors are integrated directly into the channel structures, which are released from the silicon substrate and made freestanding via deep reactive ion etching (DRIE) and selective dicing. The measurements show that a significant portion of the fluid flows below the pin fins in the clearance bypass region. Heat transfer correlations are developed with a new functional form that considers the strong influence of the clearance-to-diameter ratio on overall heat transfer.

13:00-14:30 Session: 3D1 Cross-Starit Inivted Session 6 Room M3

Chair&Co-Chair: Yenwen Lu & Wenhao Huang

(3D1-1) SOME RECENT PROGRESS IN NANO-MEASUREMENT AND STANDARDIZATION ……No.176

Wenhao Huang, Yuhang Chen, Tingting Luo, Xiaoning Liu
Department of Precision Machinery and Precision Instrumentation, University of Science and Technology of China, Hefei, China

Nano-measurement is one of the important fields of nanotechnology, while scanning probe microscopy (SPM) is among the most popular tools for quantitative surface characterization. In this talk, some recent progress in nano-measurement and standardization, mainly the characterizations of the drift rate and the complex three-dimensional (3D) surface roughness, will be introduced. To improve time stability of SPM instruments, practical methods are proposed and compared to measure the drift rates in x-, y- and z- directions, and an international standard (ISO 11039: 2012) has been already developed. In quantitative evaluation of surface roughness by SPM, conventional reference standards, which usually have regular structures, may not thoroughly meet the requirements in calibrating the complex surface roughness measurements. As a result, we propose the adoption of 3D reference specimens with controllable surface parameters as a supplement of the conventional standards. The design, fabrication and characterization of the micro-/nano- scale 3D roughness specimens will be presented. In addition, possible applications of the roughness specimens will be discussed. All these investigations can enhance the value of SPM in quantitative surface nanometrology.

(3D1-2) IMMUNOASSAY USING AN IMPEDANCE SENSOR WITH PANDB-MODIFIED NANOPROBLES ……No.245

Cheng-Hsin Chuang[1], Hsun-Pei Wu[1], Yao-Wei Huang[3], Cheng-Ho Chen[2], Chun-Pei Jen[3]
[1]*Department of Mechanical Engineering, Southern Taiwan University of Science and Technology, Tainan, Taiwan*
[2]*Department of Chemical and Materials Engineering, Southern Taiwan University of Science and Technology, Tainan, Taiwan*
[3]*Department of Mechanical Engineering and Advanced Institute of Manufacturing for High-Tech Innovations, National Chung Cheng University, Chia Yi, Taiwan*

In this study, an impedance sensor with interdigital (IDT) electrode array was utilized for dielectrophoretic (DEP) immobilization of nanoprobes and impedance sensing of immunoreactivity. In order to enhance the sensitivity of impedance sensing, Al_2O_3 nanoparticles (NPs) were modified with the conductive polymer (PANDB) for binding with antibody on the outer surface as the nanoprobes (antibody-PANDB-Al_2O_3 NPs). These nanoprobes were

firstly condensed and immobilized on the IDT electrode surface by positive DEP force, then, a fluorescent protein (AF488-BSA) suspension sequentially syringed into flow chamber for immunosensing by impedance measurement. In addition, the experimental results of PANDB-based nanoprobes were compared with conventional nanoprobes modified by silane-based modification. As the experimental results, the normalized impedance increases with the concentration of BSA in the range from 1 μM to 1 nM and the sensitivity of the PANDB-based nanoprobes is higher than the silane-based nanoprobes. Consequently, we have demonstrated a rapid and high-sensitive immunoassay based on impedance sensing with DEP force.

(3D1-3) AN INTEGRATED BIONIC MICROPUMP INSPIRED BY WATER TRANSPORTATION IN PLANTS ……No.182

Liu Chong, Li Jingmin, Zhang Kaiping, Ke Xue, Xu Zheng
Key Laboratory for Micro/Nano Technology and System of Liaoning Province, Dalian University of Technology, Dalian, China

In this paper, a novel microfluidic pump is demonstrated. The micropump is inspired by water transportation in plants. It mimics the stomatal transpiration and negative pressure generated by a leaf to drive the water. It is mainly composed of a 250μm-thick SU-8 film with an array of micropores, agarose gel and a flow rate control unit. The micropores in the SU-8 film mimic the stomata on a leaf. The agarose gel is used to mimic the stomata and the mesophyll cells, respectively. They consist of an "artificial leaf" which uses stomatal transpiration and negative pressure to drive water. The flow rate control unit can change flow rate by adjusting the number of the micropores participating in transpiration. Results have shown that the flow rate can be adjusted within 0.3nl/min~2.14nl/min, and the standard deviation of flow rate can be controlled within ±5%.

(3D1-4) ELECTRIC MICROFLUIDIC PLATFORM FOR THREE DIMENSIONAL CELL CULTURE ……No.435

Shih-Kang Fan
Department of Mechanical Engineering, National Taiwan University, Taipei, Taiwan

In tissue engineering studies, it is essential to provide a biomimicking environment for in vitro cultivations of cells and further functional organ units (e.g., liver lobules, nephrons, pancreatic islets, and osteons). Biological tissues/organs consist of hierarchical organization of various extracellular matrix (ECM) molecules along with spatial arrangement of cells and soluble factors. Recently, researchers culture cells in a 3 dimensional (3D) cross-linked hydrogel which behaves as ECM offering mechanical and biochemical cues to the cells. Moreover, the shape of the photo-cross-linkable hydrogel is adjustable. The engineered geometry to the hydrogel would effectively enhance the alignment of cells and the differentiation of stem cells. However, there are some issues to be addressed to achieve highly hierarchical tissues-like structures, including it is (1) difficult shaping arbitrary geometry of hydrogels, especially non-photo-cross-linkable hydrogels, (2) complicated to deliver highly hierarchical cell arrangements in engineered hydrogels, and (3) unable to assemble various cross-linked hydrogels containing different cells for co-culture. Here, we adapt our investigations of electric microfluidic platform to the application of tissue engineering based on the three demonstrated features of the platform that is general to (A) fluid conductivity, (B) fluid geometry, and (C) object scale. Applying the three features, we propose to achieve: (A) generation and manipulation of various cross-linkable prepolymer solution droplets by electrowetting-on-dielectric (EWOD) and dielectrophoresis (DEP), (B) shaping of prepolymer solution droplets by DEP, (C) arrangement of cells in prepolymer solution droplets and cross-linked hydrogel blocks by EWOD and DEP. Moreover, the platform is proposed to obtain three major goals: (1) concentrating and arranging cells on the μm scale, (2) shaping and actuating prepolymer solution droplets on the 100's μm scale, and (3) assembling multiple cell/hydrogel pairs for co-culture studies on the mm-cm scale.

(3D1-5) HYBRID LITHOGRAPHY SYSTEM FOR MEMS/NEMS……No.194

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Micro/nano structures are involved in MEMS/NEMS, SPs sensors, and optical devices with kinetic optical effects, which cannot be mixture fabricated on curved surface by conventional lithography for the frozen processing in the vertical direction. In this letter, a hybrid-lithography system for micro/nano structures is proposed, which mainly consists of a spatial light modulator (SLM), binary phase light modulator (PLM) and UV optical head equipped with position sensor. It is the SLM and PLM as well as auto-optical focusing (AOF) and Z-correction that make micro/nano hybrid fabrication on bended surface available. The proposed system could automatically focus on the photoresist surface with accuracy of 0.3 μm in Z-direction and achieve minimum feature size of 100 nm at 351 nm lithography wavelength. The obtained maximum speed of 2400 mm2/min is the fastest one in the world, when the system flying exposes with 3D navigation under the beam-tiled-flash-patterning (BTFP) scan mode.

13:00-14:30 Session: 3E1 Micro/nanofluidics&Bio Chips 2 Room EIII

Chair&Co-Chair: Ting Zhang & Junbo Wang

(3E1-1-IS-4) A MICROFLUIDIC SYSTEM ENABLING CONTINUOUS CHARACTERIZATION OF SINGLE-CELL SPECIFIC MEMBRANE CAPACITANCE AND CYTOPLASM CONDUCTIVITY ……No.204

Yang Zhao[1], Deyong Chen[1], Hao Li[1], Yana Luo[1], Bin Deng[1], Song-Bin Huang[2], Tzu-Keng Chiu[2], Min-Hsien Wu[2], Rong Long[3], **Junbo Wang**[1], and Jian Chen[1]
[1]*State Key Laboratory of Transducer Technology, Institute of Electronics, Chinese Academy of Sciences, Beijing, China*
[2]*Institute of Biochemical and Biomedical Engineering, Chang Gung University, Taoyuan, Taiwan*
[3]*Department of Mechanical Engineering, University of Colorado at Boulder, Boulder, CO, USA*

This paper presents a microfluidic system enabling continuous characterization of specific membrane capacitance (Cspecific membrane) and cytoplasm

conductivity (σcytoplasm) of single biological cells. In this study, cells were aspirated through a constriction channel while cell elongations and impedance profiles at 1 kHz and 100 kHz were measured simultaneously using microscopy imaging and a lock-in amplifier. Based on the proposed equivalent circuit model, raw data were translated to Cspecific membrane and σcytoplasm, which were 3.67±1.00 vs. 4.53±1.51 μF/cm2 and 0.47±0.09 vs. 0.55±0.14 S/m for the kidney tumor cell line of 786-O (n=302) and the vascular smooth muscle cell line of T2 (n=216), respectively.

(3E1-2) CONTROLLABLE ELASTOCAPILLARY FOLDING OF SILICON NITRIDE 3D STRUCTURES BY THROUGH-WAFER FILLING ……No.277

A. Legrain, T.G. Janson, J.W. Berenschot, G.J.M. Krijnen, L. Abelmann and N.R. Tas

MESA+ Institute for Nanotechnology, University of Twente, The Netherlands

We present the controllable capillary folding of planar silicon nitride templates into 3D micro-structures by means of through-wafer liquid application. We demonstrate for the first time hydro-mechanical, repeatable, actuation of capillary folded structures via addition or retraction of water on demand.

(3E1-3) FLUID DYNAMICS ANALYSIS OF MAGNETICALLY ACTUATED CILIATED NANO/MICRO STRUCTURES FOR FLOW MIXING AND PROPULSION APPLICATIONS ……No.294

Cheng-Yi Lin[1], Chia-Yun Chen[2], Ya-Ting Hu[1], Chia-Yuan Chen[1]

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A series of cilium-like micro structures with magnetic particles embedded were fabricated for precise flow manipulation through the magnetically driven control. A hydrodynamic analysis was performed to elucidate the underlying interaction between ciliated structures and the induced flow fields. To fabricate ciliated structures, the micromachining method together with a casting process was employed. These ciliated structures were actuated in a homogeneous magnetic field generated by an in-house magnetic coil system for various beating cycles inside a microchannel. Three representative signal waveforms were created to mimic the beating nature of cilia for different flow actuating functions, such as micromixing and micropropulsion. To investigate the flow structures of induced flow fields quantitatively, a numerical modeling method using Fluid-Structure-Interaction module was performed. In addition, a micro-particle image velocimetry (μPIV) experiment was conducted to characterize the nonreciprocal movement of ciliated structures for the quantification of hydrodynamic efficiency. By means of the presented analysis paradigms, a new flow manipulation strategy will be suggested to transport/agitate flows efficiently in microfluidics.

(3E1-4) MEMS MODELING OF THE POSTERIOR SEMICIRCULAR CANAL FOR TREATING BENIGN PAROXYSMAL POSITIONAL VERTIGO ……No.332

Deepan Kishore Kumar[1], Anomitra Banerjee[2], Sundaram Swaminathan[3], Mustafa Mahesri[4]

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In this paper, we study the Posterior Semicircular Canal of the Peripheral Vestibular system containing moving Otoconia (Calcium Carbonate crystals) which leads to the condition of Benign Paroxysmal Positional Vertigo (BPPV). Using the governing equations of the affected semicircular canal we develop a novel MEMS device to mimic the pathophysiological condition wherein the kinocilia structure is modeled using PZT-2 micro-cantilever placed at various positions in the device to sense the position of the otoconia. The deflection produces a voltage of 0.416 mV indicating the proximity of the particles. Using this information we describe a functional block of this device that aids in treating BPPV via an audio assisted CRP.

(3E1-5) A CHAOTIC BUBBLE MIXER MICROFLUIDIC DEVICE FOR RAPID DETECTION OF BLADDER CANCER USING BEAD-BASED ELISA ……No.387

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We proposed a simple method for rapid fluid mixing by generating tiny bubble in the fluid. The tiny bubble is levitated by the buoyancy force from the bottom of the chip and thus enhances the fluid convection. A natural wood with pore size of around 100 nm was used to disperse air to micro-bubble in the fluid. The proposed bubble-induced micro-mixer was applied for the measurement of a bladder cancer biomarker, APOA1 through the magnetic bead-based ELISA. Experimental data show that it greatly shorts the incubation time of the ELISA from 60 min to 8 min. In addition, the detection range of biomarker reaches 9000 ng/ml without any dilute process, which is around 40 times larger than the range of using 96-well ELISA with the same kit. Furthermore, the detection limit is 5 ng/ml that is smaller than the cutoff value (11.16 ng/ml) of bladder cancer patient. The proposed method is promising for point-of-care system.

14:30-15:30	Session:3B2	Session:3C2	Session:3D2	Session:3E2
Room	F1	M2	M3	EIII
Topic	Micro/nano Sensors, Actuators	Integration & Application	Cross-Starit Inivted Session	Flexible MEMS, Sensors

	& Systems 3	of M/NEMS	7	and Printed Electronics 2
Chair	Wenjiang Shen	Lianqing Liu	Da-Jeng Yao	Dong Sun
&Co-Chair	& Dongfang Wang	& Haidong Liu	& Wei Wang	& ChengHsin Chuang
Paper ID	322,324,381,393	186,200,345,362,390	340,402,550	466,371,300,280,501

14:30-15:30 Session: 3B2 Micro/nano Sensors, Actuators & Systems 3 Room F1

Chair&Co-Chair: Wenjiang Shen & Dongfang Wang

(3B2-1) COMPARATIVE STUDY OF A HIGH PRESSURE SENSOR WITH RECTANGULAR DIAPHRAGM ……No.322

Z. Niu, Y. L. Zhao, B.Tian, F. F. Guo

State Key Laboratory for Manufacturing Systems Engineering, Institute of Precision Engineering, School of Mechanical Engineering, Xi'an Jiaotong University, Xi'an, China

This paper describes a comparative study between two kinds of high pressure sensors with rectangular diaphragm structure. In order to prove results of the study, the stress distributions of the rectangular membrane structure sensors were presented in this article. The stress distribution of the piezoresistance on the membrane was analyzed by the Finite Element Method (FEM) utilizing the ANSYS software. The two kinds of rectangular membrane structure sensors were fabricated with consistent process. The results of the comparative analysis indicate that the improvements of the sensing unit structure can enhance the sensitivity of the high pressure sensor and extend the measurement range of the sensor. Meanwhile, the accuracy requirement from double-sided lithography alignment is relatively low, which could ensure the rate of yield.

(3B2-2) LOW-STRESS PACKAGING FOR A MEMS ATMOSPHERE PRESSURE SENSOR ……No.324

Mengying Zhang[1,2], Zhan Zhao[1], Lidong Du[1], Zhen Fang[1]

[1]*State Key Laboratory of Transducer Technology, Institute of Electronics, Chinese Academy of Sciences, Beijing, China*

[2]*University of Chinese Academy of Sciences, Beijing, China*

In this paper, a kind of plastic packaging for a MEMS pressure sensor is introduced. The materials and parameters of the packaging are selected and optimized to reduce additional stresses from packaging system so as to improve stability of the device. The packaging system is designed according to dimensions and functions of a kind of silicon piezoresistive pressure sensor. We choose silicon rubber as adhesive to bond chips onto lead-frames instead of epoxy to reduce stresses caused by thermal mismatch. Silicon gel is used to fill in the capsule to protect chip and wires, and the characters of the materials are studied for better stability.

(3B2-3) A TUNABLE METAMATERIAL ABSORBER EMPLOYING MEMS ACTUATORS IN THZ REGIME …No.381

Tianyang Yang, Xiuhan Li, Wangqiang Zhu

Institute of Electronic and Information and Engineering, Beijing Jiaotong University, CHINA

As Micro-electromechanical Systems (MEMS) fabrication and actuation methods are very suitable to realize the tunability of metamaterials in terahertz regime, a kind of tunable metamaterial absorber based on MEMS techniques is proposed in this paper. Firstly, an improved electric ring resonator (ERR) absorber model is put forward and the geometrical parameters are optimized to improve the absorption characteristics. Then the feasible fabrication method of the movable ERR structure is discussed. By employing MEMS actuators the frequency of absorption peak is tunable. A simulated full width at half maximum (FWHM) absorbance of 4% is achieved and the simulation results demonstrate a peak absorbance greater than 98% at the whole tunable frequency range from 1.08 THz to 1.20THz.

(3B2-4) CONTACTLESS RF MEMS SWITCH USING PZT ACTUATION ……No.393

Tim Giffney[1], Miao Yu[2], K.C. Aw[1], Haixia Zhang[2]

[1]*Department of Mechanical Engineering, University of Auckland, New Zealand*

[2]*Institute of Microelectronics, Peking University, China*

RF MEMS devices are competitive for handling high frequency microwave signals. In comparison to semiconductor devices, the performance of RF MEMS devices is highly linear, minimizing signal distortion. A contactless piezoelectric RF MEMS switch has been designed and simulated. Due to the use of a contactless design based on variable capacitance the reliability issues affecting contacting-type MEMS switches are avoided. The structure is piezoelectrically actuated using a sputtered lead zirconate titanate (PZT) layer. Finite element simulation has been conducted to optimize the structure. Electrical simulation predicts that, by achieving an on-off capacitance ratio greater than 10, isolation will exceed 15 dB over the frequency range from 4 to 15 GHz. Preliminary isolation measurements on fabricated devices without the actuating layer showed 26 dB isolation at 4 GHz, similar to that modeled, although isolation did not decrease by the modeled trend at high frequencies approaching 15 GHz.

14:30-15:30 Session: 3C2 Integration & Applicationof M/NEMS Room M2

Chair&Co-Chair: Lianqing Liu & Haidong Liu

(3C2-1) SIMULATION ON HEAT TRANSFER OF THE LIGHT SWITCHABLE MICROELECTRODE ARRAY FOR RETINAL PROSTHESIS ……No.186

Tiancong Wang, Xinyi Zhang and Zhihong Li
National Key Laboratory of Science and Technology on Micro/Nano Fabrication, Peking University, Beijing, China
The Light Switchable Microelectrode Array (LSMEA) is a novel retinal prosthetic device, which has been proposed by our group previously. In this paper, the temperature rise of the LSMEA during the operation, which is of great importance to its biocompatibility, is simulated with COMSOL Multiphysics. We obtain both stationary and transient simulation results of current density distribution and related Joule heating. The results prove that the rise of temperature is small enough to avoid heat degeneration when implanted in vivo.

(3C2-2) TISSUE MORPHOLOGY CONTROLLED BY MICROPATTERNING AND SELF-ASSEMBLY OF VASCULAR MESENCHYMAL CELLS ……No.200

Ting-Hsuan Chen[1,2], Leiting Pan[3], Xiaolu Zhu[4,5], and Chih-Ming Ho[4]
[1]*Department of Mechanical and Biomedical Engineering,* [2]*School of Creative Media, City University of Hong Kong, Hong Kong*
[3]*Key Laboratory Of Weak-Light Nonlinear Photonics, Ministry Of Education, TEDA Applied Physics School and School of Physics, Nankai University, Tianjin, China*
[4]*Mechancial and Aerospace Engineering Department, University of California, Los Angeles, USA*
[5]*School of Mechanical Engineering and Jiangsu Key Laboratory for Design, Southeast University, Nanjing, China*
Creating patterns of constituent ingredients are essential for tissue regeneration. Using vascular mesenchymal cells (VMCs) which spontaneously aggregate into multicellular structure, we demonstrate a MEMS-based method to direct the assembly of VMCs into desired tissue patterns. Incorporating the inherent chirality of VMCs revealed by micro-engineered substrates, differences in initial cell plating can be amplified into the formation of exquisite radial structures resembling the crosssectional structure of liver lobules. Furthermore, when cocultured with VMCs, vascular endothelial cells (ECs) tracked with the VMCs and formed a coherent radial pattern, indicating the applicability to heterotypical cell organization. We envision method has broad implications for building instructive microenvironment for tissue engineering.

(3C2-3) MICRO-FABRICATED MULTI-RESONANT CAPACITIVE SWITCH FOR UWB APPLICATIONS ……No.345

Min K. Yoon, Seong J. Cheon, and Jae Y. Park
Department of Electronic Engineering, Kwangwoon University, Seoul, Korea
In this study, a micro-fabricated multi-resonant capacitive switch with high isolation was successfully designed and fabricated for ultra wide band (UWB) system ranging from 3- to 10-GHz. To achieve the high isolation and wide frequency bandwidth, three capacitive shunt membranes and meander inductors were utilized to design the switch with three LC resonant switching circuits. And also, aluminum nitride film (AlN) was applied to increase on/off capacitance ratio of the micro-fabricated capacitive switch. The dielectric constant and tangent loss of the AlN film were 8.8 and 0.008, respectively. The measured on-state and off-state capacitances of each capacitive shunt switch were approximately 52 fF and 3.1 pF. The capacitance ratio was approximately 59. The fabricated resonant switch exhibited the high isolation of over 30dB at the frequencies ranging from 5- to 10-GHz and 70 dB at 6.5GHz. The size and volume of the fabricated switch were approximately 1.4 × 1.7 × 0.0083 (H) mm^3.

(3C2-4) PARAMETRIC RESEARCH OF MEMS SAFETY AND ARMING SYSTEM ……No.362

Wang Fufu, Lou Wenzhong, Fu Yue, Wang Ying
State Key Laboratory of Mechatronics Engineering and Control, Beijing Institute of Technology, Beijing, China
In this paper, a planar-zigzag-type multi-slot S&A system has been proposed. The system consists of the MEMS W-type micro-spring, slider and zigzag slot. Through simulating and analyzing the micro-spring by applying ANSYS, establishing the mathematical model of the motion for the slider and simulating the physical model by the non-linear dynamic mechanics, appropriate Micro-spring, slider and zigzag slot are designed to meet two items, one item is the micro-spring doesn't have plastic deflection under the drop overload conditions to ensure safety of the system; the other item is the slider slides to the bottom under the launch overload conditions to ensure arming of the system. Through the experiment, the feasibility of this is confirmed.

(3C2-5) STUDY OF ASIC SELF-DESTRUCTION TECHNOLOGY BASED ON MEMS INITIATOR ……No.390

Zhao Yue, Li Kang, Lou Wenzhong, Li Dongguang, Miao Zhihui
National Key Laboratory of Mechatronics Engineering and Control, Beijing Institute of Technology, China
School of Electronic and Optical Engineering, Nanjing University of Science and Technology, China
MEMS initiator has been developed rapidly for its low detonating power and small volume. MEMS metal bridge as one type of the MEMS initiators, which has the same process with ASIC (Application-specific integrated circuit). In this paper, one novel ASIC self-destruction technology in chip level mainly based on MEMS metal bridge initiator is presented. A typical experimental structure was designed. Based on this structure, a simulation model was built. Through the simulation, when the MEMS metal bridge made by proper material was excited by pulse current, the circuits of the ASIC could be destroyed immediately because of the electric blasting produced by excited metal bridge. The conclusion was that the self-destruction technology can achieve the self-destruction of ASIC in chip level.

14:30-15:30 Session: 3D2 Cross-Starit Inivted Session 7 Room M3

Chair&Co-Chair: Da-Jeng Yao & Wei Wang

(3D2-1) ELECTROSPUN PVDF NANOFIBERS AND APPLICATIONS ……No.340

Daoheng Sun, Tingping Lei, Yuanzhe Su, Xiaochun Qiu, Lingyun Wang, Dezhi Wu, Gaofeng Zheng
Dept. of Mechanical and Electrical Engineering, Xiamen University, China

PVDF nanofibers has potential wide applications because of its unique characteristics. Electrospinning is a natural nanofiber fabrication process for realizing the phase transition and polarization which is the fundamentals of the piezoelectric effect. PVDF nanofibers electrospinning process, process induced phase transition, energy transducing effect and some application examples are presented in the presentation. PVDF nanofibers with piezoelectric effect could be spun directly through both conventional electrospinning (Far-field Electrospinning, FFES) and Near-Field Electrospinning (NFES). In order to analyze the mechanism of the piezoelectric effect generation, mechanical spinning and mechanical drawing process was also investigated. Vibration—piezoelectricity transducer based on nanofibers mat was fabricated, and the measured results show that some process parameters such as solvent ratio pays important role in the transduction efficiency. As application examples, pressure sensor, battery separator based on the PVDF nanofibers are given. The properties of the sensor and the separator are also talk about.

(3D2-2) MELTING ANALYSIS USING BEAD-BASED MICROFLUIDICS FOR SINGLE NUCLEOTIDE POLYMORPHISM DETECTION ……No.402

Yen-Wen Lu[1], Shih-Torng Ding[2], En-Chung Lin[2], Lon (Alex) Wang[3], Pei-Chun Kao[1], Kan-Chien Li[1]
[1]Department of Bio-Industrial Mechatronics Engineering, [2]Department of Animal Science and Technology, [3]Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan

A miniaturized genotyping system was developed by using a bead-based microfluidic device and conducting melting analysis on the target DNA samples. The system offered a rapid genotyping scheme, which utilizes commonly-used microbeads conjugated to designed probes with gene targets forming a duplex for DNA melting analysis. Ataxia-telangiectasia mutation (ATM) gene, which had proven to be a major bio-marker associated with reproductive performance, was used to demonstrate the applications of our system by using the results from melting analysis in SNP detection.

(3D2-3) COOLING STIMULATION ON CEREBRAL CORTEX FOR EPILEPSY SUPPRESSION WITH INTEGRATION OF MICRO-INVASIVE ELECTRODES AND TE COOLERS ……No.550

Jin-Chern Chiou[1, 2], Lei-Chun Chou[1], Shang-Wei Tsai[1], Kuan-Chou Hou[1], Chih-Wei Chang[1]
[1]National Chiao-Tung University, Hsinchu City, Taiwan
[2]China Medical University, Taichung City, Taiwan

Epilepsy suppression with cooling stimulation is the primary purpose for this study. In this dissertation, cooling stimulation was implemented and demonstrated on cerebral cortex of rats. Electrodes with needle structure was designed and fabricated by using MEMS technology to minimize the size of device. A TE cooler was used to create cooling source and it can be control via electrical current. A cooler component was integrated with an electrode and a TE cooler, in addition, a thermal sensor was also combined with it to detect temperature variation, which was affected by cooling cerebral cortex. The cooler components were implanted on surface of cerebral with deep brain stimulation and the thermal sensors were penetrated into cortex to measure temperature variation which can verify the functions of cooler components. In our experimental results, electrodes with needle structure can improve efficiency of epilepsy suppression due to the particular structure. Duration, frequency and average single time of epileptic waveforms were used to identify to performance of suppression.

14:30-15:30 Session: 3E2 Flexible MEMS, Sensors and Printed Electronics 2 Room EIII

Chair&Co-Chair: Dong Sun & ChengHsin Chuang

(3E2-1) DEVELOPMENT OF FLEXIBLE NEURAL PROBES USING SU-8/PARYLENE ……No.466

Zhuolin Xiang[1,2], Hao Wang[1,2], Songsong Zhang[1,3], Shih-Cheng Yen[1,2], Minkyu Je[3], Wei Mong Tsang[3], Yong-Ping Xu[1], Nitish V. Thakor[2], Dim-Lee Kwong[3], Chengkuo Lee[1,2]
[1]Department of Electrical & Computer Eng., National University of Singapore, Singapore
[2]Singapore Institute for Neurotechnology (SINAPSE), National University of Singapore, Singapore
*[3]Institute of Microelectronics, Agency for Science, Technology and Research (A*STAR), Singapore*

A new process for making SU-8 neural probe with fluidic channels and gold electrodes based on multi-layered thin parylene and SU-8 is presented here. This approach can realize a thin 15 μm gap between electrode surface and neural cells. The thin gap will help to enhance the neural signal acquisition. Fluidic testing and mechanical testing are conducted to ensure the device reliability.

(3E2-2) STRETCHING-TUNABLE METAL GRATINGS ON ELASTIC PDMS SUBSTRATE ……No.371

Min Ji, Yan Xuan, Changsheng Yuan, Haixiong Ge, Yanfeng Chen
National Laboratory of Solid State Microstructures and Department of Materials Science and Engineering, College of Engineering and Applied Sciences, Nanjing University, Nanjing 210093, China

Stretching-tunable metal gratings were fabricated on elastic PDMS substrates by nanoimprint lithography combining with a metal transfer method using a sacrificed patterned layer. Water-soluble polyvinylalcohol (PVA) grating patterns were formed by a bi-layer imprint method. A 50nm thick chromium film was deposited on the PVA gratings, and then the PDMS substrate was pressed on the metal deposited PVA grating. Metal lines with a period of 550nm and linewidth of 270nm were finally transferred onto the polydimethylsilxane (PDMS) sheets by dissolving the underlying PVA gratings in hot water with high yield (more than 90%). Optical diffraction tests demonstrated that the period of the metal gratings can be adjusted by stretching the PDMS sheets parallel and perpendicular to the grating direction. This method may have a potential application for fabrication of a low-cost, large-scale metal device on flexible substrates.

(3E2-3) FLEXIBLE PROXIMITY KEY-PANEL ……No.300

Yuh-Chung Hu*, Cheng-Tao Ho[1], Pei-Zen Chang[1]

[*]*Department of Mechanical and Electromechanical Engineering, National ILan University, ILan, Taiwan*
[1]*Institute of Applied Mechanics, National Taiwan University, Taipei, Taiwan*
This paper proposes a flexible proximity sensor fabricated by resembling print screen. The sensor unit is composed of a polyvinylidene fluoride (PVDF) layer sandwiched in between top- and bottom-electrode layers which are made of conductive silver ink. The sensing mechanism bases on the pyroelectricity of the PVDF layer. The aforesaid sandwiched sensor units are sprayed simultaneously on a flexible polyimide (PI) substrate layer by layer to form a sensor key-panel. The resembling print screen process is very low-cost. The prototype demonstrates that it is sensitive to human fingers, and therefore one of its applications is becoming for a flexible non-contact proximity key-panel for the user interface of instruments or machines. It may also be applied to proximity sensing or thermal radiation sensing. The proposed flexible proximity key-panel is also suitable for massive roll-to-roll process.

(3E2-4) ASSOCIATION OF A LOVE WAVE SENSOR TO THIN FILM MOLECULARLY IMPRINTED POLYMERS FOR NUCLEOSIDES ANALOGS DETECTION ……No.280

N. Lebal[1], H. Hallil[1], C. Dejous[1], B. Plano[1], A. Krstulja[2], R. Delepée[2], D. Rebière[1], L. A. Agrofoglio[2]
[1]*Univ. Bordeaux, IMS laboratory, CNRS UMR 5318, Univ. Bordeaux1 IPB, Talence, France*
[2]*Univ. Orleans, ICOA, CNRS UMR 7311, Orleans, France*
The overall objective of this work is to develop and validate a quantitative, non-invasive therapeutic tool to detect selected urinary modified nucleosides as biomarkers of colorectal cancer chemotherapy and to monitor in fine the efficiency of the chemotherapy. Our methodology takes the advantage of high sensitivity of acoustic biosensor combined with high selectivity and robustness of thin molecularly imprinted polymer (MIP) film. In this paper we present a process based on a thin film of a MIP of adenosine 5'-monophosphate (AMP) coating on the sensor surface which is compatible with the acoustic wave propagation. Detection tests of AMP have been performed in aqueous media. The sensor response was recorded in terms of synchronous frequency and total insertion losses after both steps: extraction from, rebinding by the MIP layer. A frequency decrease of 6,875 Hz was recorded for 25µg/mL AMP concentration.

(3E2-5) COALITION TRANSPORTATION OF CELLS WITH OPTICAL TWEEZERS ……No.501

Xiangpeng Li, Jianjun Wang, Dong Sun
Dept. of Mechanical and Biomedical Engineering, City University of Hong Kong, Hong Kong
In optical cells manipulation tasks, optical manipulation works only when the cell is located within the optical trap. Currently, due to the lack of control techniques that automatically control cell transfer while locating the cell within optical trap consistently, cells must be manipulated carefully to avoid escape from optical trap, which significantly decreases the efficiency of manipulation task. As a result, the development of a control method for rapid and accurate positioning of cells is becoming a very challenging issue. In this paper, we addressed this challenging problem by developing a unique vision feedback control method that controls both cell positioning and cell trapping simultaneously. We first establish a new geometric model to confine the cell within a local region specified near the optical trap and form a Cell-Tweezers Coalition (C-T Coalition) during manipulation. Then, a potential field function based controller is proposed to drive C-T Coalition to the desired position. Experiments of yeast cell manipulation are performed to demonstrate the effectiveness of the proposed approach.

15:45-17:30	**Technical Tour**
18:00-20:00	**Farewell Party**

Poster and Exhibition 1 (P1) : Poster Number 1P1-1P100 EII

17:00-19:00 Day1: Monday, April 8, 2013

1P1-001 **MEASUREMENT METHOD OF LIGHT TRANSMITTANCE OF LAYERED METAL-DIELECTRIC METAMATERIAL** **No.141**

Akihiro Isozaki, Tetsuo Kan, Kiyoshi Matsumoto and Isao Shimoyama
Department of Mechano-Informatics, The University of Tokyo, Japan

We propose a measurement method of light transmittance of metamaterials by directly contacting the metamaterial on a Si photodiode. Our measurement method enables direct detection of not only the propagation wave component but also the evanescent wave component through the metamaterial. In this paper, we fabricated a layered metal-dielectric metamaterial composed of Ag / Al_2O_3 layers on the Si photodiode. The transmittance property of evanescent wave was measured. This result indicates that our measurement system detects evanescent wave transferred through the fabricated metamaterial.

1P1-002 **FOCUSING REFLECTOR AND LENS WITH NON-PERIODIC PHASE-MATCHED SUBWAVELENGTH HIGH CONTRAST GRATING** **No.174**

Qinglong Yu[1], Changsheng Zhang[2], Hongbo Zhu[1], Miao Zhang[3], Yongjin Wang[1,3]
[1]*Institute of Communication Technology, Nanjing University of Posts and Telecommunications, China*
[2]*School of Opto-electronic Information Science and Technology, Yantai University, China*
[3]*State Key Laboratory of Functional Materials for Informatics, Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences, China*

In this paper, we propose novel planar subwavelength non-periodic high contrast gratings (HCGs) with excellent focusing abilities due to their phase-matched structures. Rigorous coupled-wave analysis (RCWA) method and finite-element method (FEM) are performed to investigate the non-periodic HCG structures for either focusing reflector or lens at the wavelength of 1.55μm. The structure with focusing ability is optimized to simultaneously meet the phase-matched conditions of the reflectors and lenses. When the grating bars material is silicon, the HCG serves as focusing reflector, and the HCG with the grating bars of GaN has transmission focusing ability. Both reflector and lens have large numerical aperture (NA), high diffraction efficiency and excellent focusing ability. These HCG structures are promising for designing and fabricating photonic devices that require focusing components, especially for silicon and III-nitride integrated photonic devices.

1P1-003 **LASER-INDUCED THERMOELECTRIC VOLTAGE IN $La_{0.8}Sr_{0.2}FeO_3$ THIN FILMS** **No.188**

Z. Sun, L. S. Zhang, P. J. Wang and Y. Fang
Beijing Key Lab for Nano-Photonics and Nano-Structure, Capital Normal University, Beijing, China

Laser-induced thermoelectric voltage (LITV) effect is observed firstly in $La_{0.8}Sr_{0.2}FeO_3$(LSFO) thin films grown on the vicinal cut $LaAlO_3$ (10°) substrate by pulse laser deposition(PLD). The peak voltage of LITV signals increase linearly with the pulse laser energy. The linear function is y=0.05131x-0.02084. The coefficient of determination and standard deviation for linear relationship reach 0.99667 and 0.00377 respectively. It shows a good linear relationship between peak voltage and laser energy densit from the above result. It is significant for researching the accuracy and precision of photoelectric detector.

1P1-004 **FREESTANDING WHISPERING-GALLERY MODE MICRODISK RESONATOR** **No.211**

Zheng Shi[1], Shumin He[1], Hongbo Zhu[1], Miao Zhang[2], Yongjin Wang[1,2]
[1]*Institute of Telecommunication and Technology, Nanjing University of Posts and Telecommunications, Nanjing, China*
[2]*State Key Laboratory of Functional Materials for Informatics, Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences, Shanghai, China*

This article proposes a high-Q value Whispering-Gallery Mode (WGM) microdisk resonator, which is surrounded by photonic crystal with square lattice. Finite element method (FEM) is performed to model the microdisk resonator, and an ultrahigh quality factor (Q) value of 1.37×10^8 can be achieved at the wavelength of 1435.4nm. The proposed microdisk resonator is realized on a silicon-on-insulator (SOI) substrate. These structures of the device are defined by electron beam lithography, and then transferred into silicon layer by ion beam etching. The buried oxide layer is removed to generate freestanding photonic crystal and suspended microdisk.

1P1-005 **SILVER NANOPARTICLES AGGREGATE ON PASSIVATED COPPER FOIL FOR SURFACE-ENHANCED RAMAN SCATTERING** **No.267**

Zuojun Zhang, Li Chen , Gang Chen, Chunhong Lai, Hui Zhou
Defense Key Disciplines Lab of Novel Micro-nano Devices and System Technology, Chongqing University, China
Key Laboratory of Optoelectronic Technology & Systems Ministry of Education, Chongqing University, China

Surface-enhanced Raman scattering (SERS), as a powerful tool of chemical and biological analysis, has been investigated extensively in recent years. In this work, the reduction of silver nitrate by copper foil in aqueous medium was used to prepare silver nanoparticles and a method of applying ultrasonic

to passivate the copper foil in the sulfuric acid solution was proposed in order to regulate the deposition of the Ag nanoparticles. Analysis of the surface structure by a field-emission scanning electron microscope (FESEM) revealed that the silver nanoparticles deposited on the passivated copper foil were more regular. SERS spectra of Rhodamine6G (R6G) adsorbed on these Ag-Cu substrates were studied and compared. It's found that the Ag-Cu substrate prepared with the Cu foil passivated by ultrasonic treatment has a significantly higher Raman signal sensitivity, better large-area uniformity, and 80% of original sensitivity was remained in 10 days of storage time in the air, indicating the substrates are fairly stable.

1P1-006 **OPTIMAL DESIGN OF PERIODIC NANOSTRUCTURES FORMED IN SOLAR CELLS AS AN ANTIREFLECTIVE LAYER ……No.274**

Yating Shi[1], Shiyuan Liu[1,2], Jinlong Zhu[1], Chuanwei Zhang[2], Xiuguo Chen[1], Zirong Tang[1]
[1]*Wuhan National Laboratory for Optoelectronics, Huazhong University of Science and Technology, China*
[2]*State Key Lab of Digital Manufacturing Equipment and Technology, Huazhong University of Science and Technology, China*

Recently, periodic nanostructures with a rectangular profile have been widely used in the backside layer of solar cells to reduce the reflectance and to enhance the performance. In this paper, we design solar cells by applying two-dimensional periodic nanostructures with a trapezoidal profile as an antireflective layer. Through intensive simulations using rigorous coupled-wave analysis (RCWA), we attempt to optimize the profile parameters, including the sidewall angle (SWA), the pitch, and the height. Simulation results indicate that the rectangular profile displays a lower reflectance than the trapezoidal profile. Moreover, when the pitch is almost double of the width and the height is 1~2 times of the width, the total reflectance is reduced by 25~35%.

1P1-007 **INDUCED-TRANSPARENCY IN SILICON-ON-INSULATOR BASED NOVEL RESONATOR SYSTEMS ……No.291**

Danfeng Cui, Chenyang Xue, Chao Liu, Liping Wei, Yonghua Wang, Jun Liu
Key Laboratory of Instrumentation Science & Dynamic Measurement (North University of China), Ministry of Education, Taiyuan 030051, China
Science and Technology on Electronic Test & Measurement Laboratory, Taiyuan 030051, China

In the paper, Coupled-resonator-induced-transparency (CRIT) phenomenon in a novel integrated on-chip optical resonator system is experimentally demonstrated. The system is composed of a four-ring resonator with 20μm diameter on silicon, whose spectrum has a narrow transparency peak with low group velocity. The CRIT effect is observed in the optical coupledresonator due to the classical destructive interference. This system can be used to study the slow and fast light experiments because of its simplicity and flexibility. In this work, a CRIT resonance with a quality factor of 7.2×10^4 is demonstrated with the same cavity size and the power coupling of the system is 60%, which agree well with the theoretical analysis. The through and drop transmission spectra of the resonator are coincided well with each other.

1P1-008 **ANALYSIS OF SECOND-ORDER RADIAL MODE DIPS IN RACETRACK OPTICAL RING RESONATOR BASED ON SOI RIB WAVEGUIDE ……No.313**

Wei Liping[1], Xue Chenyang[1], Zang Junbin[1], Cui Danfeng[1], Wang Yonghua[1], Zhang Wendong[1,2]
[1]*Science and Technology on Electronic Test & Measurement Laboratory, North University of China, China*
[2]*Key Laboratory of Instrumentation Science & Dynamic Measurement, North University of China, China*

In this paper, detailed design and analysis of a polarization mode splitting resonator based on silicon-oninsulator rib waveguide is presented. By analyzing the mode birefringence in the ultra-small rib waveguide, the directional coupler is introduced to the micro-ring resonator to realize the splitting of the quasi-TE and quasi-TM polarization modes from the same output port in specific wavelength range. It is demonstrated that after splitting the quasi-TM polarization mode, the Q value of the quasi-TE polarization mode is 23000±1000, about twice of that without splitting the quasi-TM polarization mode. This novel characteristic of race-track ring resonators is quite promising in many applications of optical components, such as the electro-optical modulators.

1P1-009 **AN ELECTROSTATICALLY-DRIVEN AND CAPACITIVELY-SENSED DIFFERENTIAL LATERAL RESONANT PRESSURE MICROSENSOR ……No.600**

Bo Xie[1,2], Hailong Jiao[1,2], Junbo Wang[1], Deyong Chen[1], and Jian Chen[1]
[1]*State Key Laboratory of Transducer Technology, Institute of Electronics, Chinese Academy of Sciences, Beijing, China*
[2]*University of Chinese Academy of Sciences, Beijing, China*

This paper presents an electrostatically-driven and capacitively-sensed resonant pressure micro sensor. The device was fabricated based on a SOI wafer requesting only 2 masks and simplified micro-fabrication steps including DRIE, sputter and wet etching. The sensor was quantified by an open loop system, producing a Q-factor higher than 10430 in vacuum (less than 0.5 Pa). The resonant frequency was shown to change linearly in response to applied pressure ranging from 50 kPa to 110 kPa. Experimental data analysis confirmed a sensitivity of 214 Hz/Kpa with a linear correlativity of 0.99997.

1P1-010 **GRAPHENE FILMS SYNTHESIZED ON ELECTROPLATED CU BY CHEMICAL VAPOR DEPOSITION ……No.126**

Wenrong Wang[1,2], Chen Liang[1,2], Tie Li[1], Heng Yang[1], Na Lu[1] and Yuelin Wang
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In this paper, electroplated Cu was used as substrate to grow graphene by chemical vapor deposition (CVD) with a mixture gas of methane, hydrogen and argon. The different electroplated Cu gain size after annealing was studied. We present the growth temperature, growth time and methane concentration are key parameters that affect the structural perfection of graphene.

1P1-011 **CHARACTERIZATION OF FLUID RESISTANCE IN NANOSTRUCTURED TiO_2 (NST) FILM ……No.157**

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Embedded microchannels are required in many microfluidic devices. However, the channels may reduce the strength of the bulk substrate. In this study, Nanostructured TiO2(NST) material is proposed to provide the fluid passage for the drug into the required location while still maintains very good strength. A simple method was proposed to obtain the pressure drop over NST filled channel and the fluid resistance was experimentally determined. The Darcy' equation of NST films was setup, and the permeability was measured 1.475×10^{-11} m^2. With a relatively high fluid resistance, further optimization should be carried out for NST microfluidic devices.

1P1-012 **NANOPARTICLES SYNTHESIS AND SELF-ASSEMBLY BASED ON PLASMA-INDUCED RIPENING OF AG FILM ON SI SUBSTRATE ……No.217**

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A simple and low cost nanoparticle synthesis and self-assembly process based on the plasma induced ripening of Ag films is demonstrated. Ag films are deposited on p-doped Si substrates using a DC magnetron sputtering. With the assistance of O_2/Ar plasma treatment, different sizes and densities of Ag nanoparticles are formed. The morphology of the samples is characterized by scanning electron microscopy. A clear decrease in the mean particle size and an increase in particle density are observed with increasing plasma power. Meanwhile, treatment time and plasma composition could be other two parameters which can affect the nanoparticles assembly process. SERS and PL enhancement of Ag nanoparticles is studied. From the experimental results, it provides a controllable method of changing the nanoparticle distribution on substrates, which has potential applications in the fields of solar cells, biosensors, and catalysis.

1P1-013 **FABRICATION OF HYDROPHOBIC SURFACES WITH FLUORINATED ACRYLIC RESIN AND AMIDOGEN MODIFIED SILICA NANOPARTICLES ……No.228**

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This study focus on the modification of nano silica by silane coupling agent of KH550 at optimal production parameters. The effects of KH550 under different pretreatment conditions, the amounts of KH550 added on the properties of nano silica were investigated by FTIR and TG-DTA detections. Then the nano silica and fluorinated resin composites were prepared and the preferable reactive conditions were determined. The properties of the dielectric loss ($\tan\delta$) were investigated by the electric capacitance. The transparency and hydrophobic abilities were investigated by UV-Vis spectroscopy and static contact angle values.

1P1-014 **DEVELOPMENT OF CLUSTER ION SOURCE BASED ON MODULATED PULSE POWER MAGNETRON SPUTTERING TECHNIQUE ……No.239**

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A new ion source based on modulated pulse power (MPP) magnetron sputtering (MSP) was developed and demonstrated for cluster production. By employing MPP-MSP, both silver and silicon cluster beams were produced and analyzed by a quadrupole mass spectrometer. It is found that the maximum intensity of silver cluster anions reaches 500 pA, which is considerably higher than that with a conventional DC-MSP. For silicon cluster cation, the overall ion intensity of the cluster beam by MPP-MSP is about three times higher than that generated by DC-MSP.

1P1-015 **WATER SPLITTING EFFECT ON PHOTOANODE MADE OF ZINC OXIDE NANORODS COATED WITH TUNGSTEN TRIOXIDE NANOPARTICLES ……No.247**

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The combination of semiconductor metal oxides with different band gaps is an effective strategy to widen the light absorption spectrum. In this work, zinc oxide (ZnO) nanorods coated with tungsten trioxide (WO_3) nanoparticles were successfully synthesized via hydrothermal method followed by deposition from aqueous suspensions. ZnO/WO3 nanorods were observed to be densely and uniformly packed with high aspect ratio. This is consistent with the X-ray diffraction (XRD) analysis. Photoluminescence (PL) spectrum reveals that the as-synthesized ZnO/WO_3 nanorods exhibit stronger emission centered at around 600nm, compared with pristine ZnO nanorods. Light absorption spectrum presents higher absorption over wider wavelength range. Photoelectrochemical (PEC) properties were investigated in a standard three-electrode system. The prepared ZnO/WO_3 nanorods show increment (45%) in photocurrent density and improvement (20%) in maximum photocurrent conversion efficiency (PCE). These enhancements are mainly attributed to the extension of the light absorption and improved charge transport of WO3 nanoparticles integrated ZnO nanorods.

1P1-016 **SYNTHESIS OF SUPERPARAMAGETIC IRON OXIDE NANOPARTICLES IN CARBON REDUCTION METHOD ……No.292**

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The current paper presents our new approach in synthesizing superparamagetic iron oxide nanoparticles. The Fe3O4 nanoparticles (~500nm) are synthsized through carbon reduction method, which is a brand new method. The best parameters of this method are fixed through characterizing transmission electron microscope (TEM), X-Ray Diffraction (XRD) and Vibrating Sample Magnetometer (VSM) of the Fe3O4 nanoparticles synthsized under different experimental conditions. The TEM characterization results show that the best ratio of the carbon and ferric chloride is 3:1 and the most suitable calcining time is 3 hours. The nanoparticles, which were obtained with furnace cooling under vacuum condition after 3 hours calcining, have the best magnetic properties and most stable crystal from. Moreover, the quantitative analysis of this new method is taken to confirm the repeatability of this method. The actual qualities of the Fe3O4 nanoparticles are always consistent with the theoretical one, which indicates that the repeatability of this method is excellent.

1P1-017 **NEW CONSTANT *C* TO CHARACTERIZE STRUCTURE DISORDER OF POLYSILICON THIN FILMS GROWN BY DIFFERENT PROCESSING FOR MEMS DEVICE APPLICATIONS ……No.303**

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The topic category of this paper is Nanomaterials. The structure information of LPCVD polysilicon (p-Si) films have been studied by XRD, SEM and TEM [1]. The structural depth profiles of p-Si films have been obtained by Raman spectroscopy at different excitation wavelengths and by a higher spatial resolution approach using microline focus Raman spectroscopy [2]. Flat, low-stress (LS), boron-doped (B-doped) p-Si films were prepared on crystalline silicon substrates by LPCVD. They are characterized by XPS, XRD and Raman, respectively. The work in this paper focuses on disorder degree, characterized by a new constant *C*. The disorder state of p-Si films can be determined by the constant *C*.

1P1-018 **LOW TEMPERATURE CASTING OF GRAPHENE INTO VARIOUS 3-D SHAPES ……No.348**

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Here we report a pH-mediated hydrothermal reduction method that combined with moulding methods, realizing fabrication of ultrahigh density grapheme macrostructures with various shapes. This 'compact graphene' (CG) has a compressive strength of 361 MPa (6 times higher than conventional graphite products) and an excellent electrical conductivity. The processing steps are scalable and may contribute to new products. CG structures may be an ideal irradiation protection material for aerospace, atomic energy, and nuclear science due to its high density.

1P1-019 **EFFECT OF RF SPUTTERING PARAMETERS ON PZT CRYSTAL GROWTH ……No.378**

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Lead zirconate titanate(PZT) due to its large polarization, large dielectric constant and good piezoelectric performance has become popular in a wide range of applications in MEMS field. The prevailing technique for PZT deposition is sol-gel method, but the stability of solution and repeated coating can't be precisely controlled. Sputtering technique is used in this work for its relatively simple fabrication process, uniform thickness. In this work, PZT films are sputtered on $Pt/Ti/SiO_2/Si$ substrate prior to annealing. PZT preferential orientation is highly depend on the sputtering parameters. X-ray diffraction(XRD) analysis has been performed to compare the crystal growth. TiO2 seed layer is also introduced in this work.

1P1-020 **FIRST-PRINCIPLES STUDY ON THE ELECTRO-MECHANICAL COUPLING OF THE Si/Ge CORE-SHELL NANOWIRES ……No.382**

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We have simulated the piezoresistance coefficients (Pie coefficients) in Si/Ge core-shell nanowires with a certain diameter and different thickness Ge-shell in the longitudinal direction on the basis of First-Principles calculations of models. Through calculations, it was found that the Pie coefficients of the nanowire constructed with an axis of Si atoms and three layers of Ge atoms outside (Si1Ge3 in Figure1) almost kept consistent with the GeNW as negative values. Under the compressive condition, the Pie coefficient of the Si2Ge2 can reach up to $-21.20\times10^{-11}Pa^{-1}$. However, when the Ge-shell was decreased to only one Ge-atom layer, the Pie coefficients varied from negative values to positive ones. We also obtained the pie coefficients of the SiNW: $9.46\times10^{-11}Pa^{-1}$ and $35.77\times10^{-11}Pa^{-1}$ respectively under compression and tension.

1P1-021 **ANALYSIS OF WATER SORPTION IN SULFONATED POLYIMIDE MEMBRANES- EFFECT OF THE MEMBRANE NANOSTRUCTURE ……No.601**

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Water sorption in sulfonic polyimides with or without ionic block structure was analysed with Feng's new dual mode model. The model parameters *Cp* and *A'* correspond to the sorbed water molecules on the first layer close to the ionic groups and on the subsequent layers, respectively. From these fitted physical parameters, the water sorption on membranes with different counter ions was studied and the hydration energy and size of counter ions were proved to have much influence on the *Cp* values. The impact of the nano / microstructure of the copolymers on the *Cp* / *A'* values and on the water sorption isotherms was discussed and compared with that for the well-known Nafion® membranes.

1P1-022 **GRAPHENE AS DRY ADHESIVE INTERACTING WITH SEMICONDUCTOR SUBSTRATES ……No.412**

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Here we show by molecular dynamics that graphene could be utilized as dry adhesive interacting with semiconductor substrates. Various potential semiconductor substrates are introduced and present similar results. This work opens up a new prospect for the applications of graphene and would be valuable for the scientific studies of adhesion at nanoscale.

1P1-023 **3D VISUALIZATION OF THE MICROSCOPIC CHARACTERISTIC IN MAGNETORHEOLOGICALFLUIDS …No.448**

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The 3D microstructure and the rheology of Magnetorheological (MR) fluids are investigated using digital micro holography. A digital micro holographic system which can measures the rheological mechanism of MR fluids is presented. To accurately locate the focal plane of the particles in MR Fluids in digital holography, the overall-sharpness method is introduced which can effectively eliminate the noise on the focal plane determination. The two-threshold and image segmentation methods were used to obtain high quality binary images from which we can get satisfied measurement results of particle size and chain structure. The size distributions and the 3D visualization of microscopic characteristic of MR fluids are effectively measured. The experiment results show the digital holography is a well tool for measurement of the behaviors of MR fluids.

1P1-024 **EFFECTS OF THREE PARAMETERS ON GRAPHENE SYNTHESIS BY CHEMICAL VAPOR DEPOSITION ……No.449**

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A high quality graphene film on a copper foil was successfully grown by a CVD process using ethanol as a carbon source. The effect of growth temperatures (650-850°C), reaction times (5-50 min) and post-CVD cooling process rates (slow-cooling, fast-cooling and fast-cooling under ethanol exposure) on the formation of graphenes was investigated by Raman spectroscopy and scanning electron microscopy (SEM). The graphene film deposited under the optimal conditions showed features of a high quality such as a high I2D/IG ratio of ~8, a low ID/IG ratio of 0.28 and a narrow full width half maximum (FWHM) of Lorentzian-shaped 2D peak of ~35 cm^{-1}. It was found that the quality of graphene film could be enhanced by optimizing the growth temperature and time, while the number of graphene layer was less sensitive to the cooling rate. However, the fast cooling process under ethanol exposure was found to be a key process for obtaining graphenes with a large domain size. These findings may help to fabricate high-quality graphenes on a copper foil for electronic applications.

1P1-025 **SOFT MAGNETIC PROPERTIES OF $Ni_{81}Fe_{19}$ FILM WITH DIFFERENT SUBSTRATES USED FOR MICRO-FLUXGATE ……No.451**

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The soft magnetic properties of Ni81Fe19 films respectively with Ti, Ta and Cr substrates used for micro-fluxgate have been studied in this paper. The films were characterized using transmission electron microscope (TEM), X-ray diffraction (XRD) and vibrating sample magnetometer (VSM). The testing results showed that Ta substrate film, due to its ladder rising hysteresis loop, is more appropriate for fluxgate core in these four kinds of Ni81Fe19 films, film with no substrate and film with Ti substrate take the second place and the Cr substrate film would not be suitable as fluxgate core because of its bad soft magnetic properties.

1P1-026 **FABRICATION OF COPPER NANOWIRES BY ELECTRODEPOSITION USING ANODIC ALUMINUM OXIDE TEMPLATE ……No.465**

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In this paper, effects of potential and output mode on copper nanowire arrays via porous anodic aluminum oxide template by electrochemical deposition method have been investigated. The copper nanowire arrays were fabricated using electrochemical deposition in 0.2 M CuSO4 by different potential modes including direct current (DC) and pulse. The nanostructure, morphology, chemical composition and phase of copper nanowire arrays were examined by scanning electron microscopy and grazing incidence X-ray diffraction. The results indicated that the copper nanowire arrays deposited by pulse mode revealed high aspect ratio despite high potential while that at higher DC potential was rather short due to the hydrogen generation in reduction reaction. The short duty cycle of 50% in pulse deposition can release the produced hydrogen for good nanowires formation.

1P1-027 **MECHANICAL DURABILITY OF MICRO-NANO STRUCTURES SURFACE OF BLACK SILICON PRODUCED BY FEMTOSECOND LASER ……No.526**

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Hierarchical micro-nano structure surface on silicon is directly produced by femtosecond laser in air. The laser processing reduces the reflectance of silicon significantly in the studied wavelength range. Mechanical durability of the micro-nano structure surface has been studied. It is indicated that wear is significantly reduced under water saturation lubrication. Moreover surface modification with Perfluoropolyether improves its mechanical durability.

1P1-028 **MECHANICAL PROPERTY OF NANOSCALE ZnO/Al_2O_3 MULTILAYERS: AN INVESTIGATION BY NANO-INDENTATION** No.527

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Nanoscale ZnO/Al_2O_3 multilayers were prepared on Silicon substrates by atomic layer deposition (ALD) method at 200°C. To understand the size effect of ZnO nanoscale layers on hardness, the mechanical properties of the ZnO/ Al_2O_3 multilayers were investigated using nano-indentation technique. As the bilayer period decreases from 60 to 2 nm, the micro-structures of ZnO layers changed from polycrystalline to amorphous. In the bilayer period interval of 60 to 6 nm, the variation of hardness versus bilayer period is similar to Hall-Patch relation, with maximum hardness and elastic modulus of ~10.69GPa and ~138.1GPa, respectively. However when the bilayer period is smaller than 6 nm, the nanolaminates became softer than the single ZnO film.

1P1-029 **SYNTHESIS OF ANTIBACTERIAL TiO_2/PLGA COMPOSITE BIOFILMS** No.121

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The main purpose of this study was to develop a TiO_2/PLGA composite biomaterial for artificial dressing applications. *E. coli* and *S. aureus* were used as biological indicators for the disinfection efficiency of the proposed TiO_2/PLGA composite. Various concentration ratios of TiO_2 verse PLGA were implemented to optimize the disinfection efficiency of the composite biomaterial. Cell seedings of BECs and L929s on the TiO_2/PLGA composite biomaterial are further conducted to evaluate the feasibility of the TiO_2/PLGA composite biomaterial on wound healing applications. Experimental results illustrated that TiO_2/PLGA composite biofilms containing 10% of TiO_2 nanoparticles revealed an effective antibacterial property but kept a comparatively low suppression on cell growth.

1P1-030 **QUANTITATIVE CHARACTERIZATION OF SPECIFIC TARGETING OF TUMOR CELLS BY ANTIBODY-FUNCTIONALIZED PARTICLES** No.480

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Receptor-ligand binding has been one of the more popular approaches to specifically targeting tumor cells. In this work, targeting efficiency was quantitatively characterized using silica particles functionalized with EpCAM antibodies and EpCAM-expressing BT-20 breast cancer cells. The effects of incubation time and particle concentration on the number of functionalized particles bound to target cells were experimentally investigated. The number of bound particles was found to increase with particle concentration, but not necessarily with incubation time. While particle desorption and cellular loss of binding affinity in time seem to be negligible, cell-particle-cell interaction was identified as the limiting mechanism for the number of particles bound to target cells. The current findings suggest that separation of a bound particle from a cell may be detrimental to cellular binding affinity.

1P1-031 **NUMERICAL SIMULATION ON PATTERN FORMATION BY VASCULAR MESENCHYMAL CELLS BASED ON THE EXOGENOUS SOURCE OF ACTIVATOR** No.284

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This paper mainly explores the Turing patterns and pattern transferring of the vascular mesenchymal cells by external addition of activator. First, we perform a one-dimensional analysis to obtain the Turing space of the exogenous source of activator, and then explore the various Turing patterns with varying the ratio of the diffusion coefficients of activator and inhibitor, because of the essence of Turing bifurcation. Simulation results show that the Turing patterns range from spots to stripes, next labyrinths and finally holes with increasing the ratio or the dosage of the exogenous source of activator, or in other words, from dense to sparse. Furthermore, we explore the patterns transferring in the bistability system, and obtain the secondary patterns of the diverse patterns by altering the external addition of activator and various secondary patterns can be transferred from an initial pattern.

1P1-032 **IMPROVEMENT OF DNA ORIGAMI'S ADSORPTION ON SILICON SUBSTRATE** No.335

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DNA origami, in which a long single strand of DNA is folded into a shape using shorter 'staple Strands', promises low-cost ways to create nanoscale shapes and can even display patterns of binding sites of 6-nm-resolution, in principle allowing complex arrangements of carbon nanotubes, silicon nanowires, or quantum dots [1]. However, adsorption of origami appears better results on mica substrate, which cannot compatible with the complementary metal oxide semiconductor (CMOS) process. Here we describe a method to improve the adsorption of origami on silicon substrate, by quantitative control of the adsorption conditions, which will hopefully make contributions for churning out nanoscale shapes with CMOS process in the future.

1P1-033 **THE PHOTODIODES BASED ON THIN FILM ORGANIC ELECTRONIC DEVICE ……No.464**

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In this study, we propose the detection of the black shutter using thin film organic photodiodes. The device structure include hole transporting layer, polyethylenedioxythiophene: Poly-styrenesulphonate (PEDOT:PSS), active layer, poly(3-hexylthiophene): [6,6]-phenyl-C61-butyric acid methyl ester (P3HT:PCBM), indium tin oxide anode (ITO), and Al or LiF/Al cathode. The optimal opto-electronics effect of device structure was it had 150℃ heating process, active layer had 105 nm thicknesses and had LiF/Al cathode. The output voltage test used 1000W simulator and 20W fluorescent light, we got the 0.5V and 0.25V difference, respectively. Output voltage difference is 10 times more than the dye-sensitized photovoltaic cell [1]. Obviously, thin film organic photodiodes can be expected applications in the wearable eye-gaze tracking systems. It is expectation to measure the signs of thin film organic photodiodes array and make the relative devices or systems in future.

1P1-034 **USE OF CELL MORPHOLOGY AS AN EARLY BIO-SENSOR FOR VIRAL INFECTION ……No.505**

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This paper reports a correlation between cellular morphology and the ability of adapting Vesicular stomatitis virus (VSV) infection. A time-lapse approach was employed to track the individual difference between homologous cells in adopting viral infection. Our single-cell analysis indicates that upon viral infection, mature cells that are in spindle shape are less likely to be infected after 24 hour infection. On the other hand, cells undergoing proliferation, which are in rounder shape, tend to adopt much higher viral infection within the same amount of time. This fact suggests cellular morphology may to be an early bio-sensor for viral infection. The findings in this paper could potentially be applied to other viral infection models.

1P1-035 **NANOFLUIDIC SERS TOWARDS DNA SEQUENCING ……No.531**

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Surface Enhanced Raman Scattering (SERS), that occurs by exciting plasmon resonances in metal structures, provides high-sensitivity detection with detailed molecular information. Here we describe the combination of SERS and nanofluidics for the molecular characterization of DNA molecules inside a nanoslit across a thin, metal coated membrane. The presence of the nanoslit results in mechanical confinement for molecules passing through the slit and in a strong field confinement upon light excitation, required for SERS. Using electrophoresis to actuate the analytes across the nanoslits, we were able to record SERS spectra of adenine, a DNA base. Similarly, short DNA oligonucleotides were also successfully detected. It is expected that the nanoslit-based fluidic SERS will become a promising real-time detection tool, even for DNA sequencing.

1P1-036 **THEORETICAL INVESTIGATION OF QUASIPARTICLE BAND STRUCTURES AND OPTICAL SPECTRA OF LARGE-DIAMETER SEMICONDUCTING SINGLE-WALLED CARBON NANOTUBES ……No.111**

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Using *ab initio* many-body perturbation theory (within GW approximation and Bethe-Salpeter equation), including electronic exchange, correlation, and electron-hole interaction effects, we study the optical properties of largediameter semiconducting single-walled carbon nanotubes (SWCNTs). The calculated energies of the lowest two optically allowed transitions (E_{11} and E_{22}) agree well with those deduced from experiments. The lowest optical allowed transition of these tubes is between the first two van Hove singularities on each side of the Fermi level, which is different from that of small-diameter tubes. The exciton binding energy for E11 is calculated, which is consistent with that of the experiments.

1P1-037 **IMPLANTABLE CNT-BASED SENSOR FOR CHONDROITIN SULFATE PROTEOGLYCANS DETECTION OF GLIAL SCAR AFTER SPINAL CORD INJURY ……No.513**

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The implantable CNT-based sensor is suggested to detect CSPGs which is main compositions of glial scar which inhibit the axonal regeneration after spinal cord injury. The suggested sensor is fabricated using spin-coated polyimide and patterned by MEMS process. Multiwalled CNT networks are formed by air spray method on the interdigitated sensor electrodes as the sensing element of CSPGs. The feasibility of the fabricated sensor is successfully confirmed in vitro by measuring the resistance change of CNT networks versus various CSPGs concentrations. The results show that the suggested sensor accurately detects the low CSPGs concentration to sense the regeneration-inhibitory effect of CSPGs.

1P1-038 **CARBON NANOTUBE BASED HEAT-SINK FOR SOLID STATE LIGHTING No.525**

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A new carbon-nanotube-based (CNTs) heat sink is developed. Due to their high thermal conductivity and aspect ratio, CNT boundles are used as fins of the heat sink. Fins as high as 300 μm with an aspect ratio of 30 are fabricated. For the thermal characterization of the heat sink, a microheater is integrated with the heat-sink and it is also used as temperature sensor. It is realized by using the low doped silicon bulk as electrical resistor. The sensor shows a sensitivity of 0.6 Ω/K. A thermal characterization is performed to evaluate the heat dissipated by the CNT-based heat-sink. Results show that up to 18% of power reduction can be achieved with the proposed CNTs-based heat-sink configuration.

1P1-039 **MICROFLUIDIC DEVICE FOR SUPER-FAST EVALUATION OF MEMBRANE PROTEIN CRYSTALLIZATION..... No.118**

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Membrane proteins embedded in bi-layer lipids of cell membrane have unique functions including inter-cell communication, ions/molecules transport. And there is more than 50% of drug design emphasizes on membrane proteins specifically studying on their structure and formation. Recently we reported the structural and functional studies of membrane protein lipid nanoparticles in native biological membrane. This virus-like nanoparticle formed by a self-assembly crystallization process of membrane protein and lipids is critical to pharmaceutical industrial. These nanoparticles have a variety of potential applications in drug delivery and drug design that can carry specific the membrane protein on aim or release control. The previous studies stay on an inefficient method with a standard dialysis process that has low-throughput, time consumption, and protein sample waste. However, the interdisciplinary cooperation between in biology and Micro electro mechanical systems (MEMS) has been tremendous developed such as Bio-MEMS and Lab-on-a-chip technologies. Here we demonstrate a new concept with a high-throughput membraneless microfluidic device to fast produce the reconstitution of membrane protein nanoparticles. The reconstitution process in continuous micro flow dominated by convection-diffusion phenomena in microfluidic channel can be completed in seconds to form protein/lipid particles under multiple conditions applied. The controllable syringe pumps is used to test a combination of conditions rather than using inefficient hand pipette. Moreover this novel microfluidic device can save protein sample consumption down to only nanoliter or picoliter. By using this device, we have an ability to rapidly form uniform membrane protein lipid nanoparticles and we believe this new method will make a transformative impact to commercial applications in variety of areas from biology to pharmacology.

1P1-040 **Integrated Lenses in Polystyrene Microfluidic Devices No.125**

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This paper reports a new method for integrating microlenses into microfluidic devices for improved observation. Two demonstration microfluidic devices were provided which were fabricated using this new technique. The integrated microlenses were fabricated using a free-surface thermocompression molding method on a polystyrene (PS) sheet which was then bonded on top of microfluidic channels as a cover plate, with the convex microlenses providing a magnified image of the channel for the easier observation of the flow in the microchannels. This approach for fabricating the integrated microlens in microfluidic devices is rapid, low cost and without the requirement of cleanroom facilities.

1P1-041 **STUDY ON TRAPPING TWO PARTICLES WITH DIELECTROPHORETIC MICROFLUIDIC CHIP No.134**

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In microfluidic field, how to capture, manipulate and separate micro-particles suspended in liquid media has very important applications. Up to now, only seldom works focused on how to trap two particles with different sizes. In order to achieve this goal, a dielectrophoretic microfluidic chip was designed. The shape of electrode and flow channel was optimized; the electric field and the flow field were simulated. At last, the chip was fabricated to verify the design. The results show that the chip is able to realize the function of pairing two particles with different sizes.

1P1-042 **LOW-COST RAPID PROTOTYPING OF FLEXIBLE PLASTIC PAPER BASED MICROFLUIDIC DEVICES No.150**

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This research presents a novel rapid prototyping method for paper-based flexible microfluidic devices. The microchannels were fabricated using laser ablation on a piece of plastic paper (permanent paper), the dimensions of the microchannels was carefully studied for various laser powers and scanning speeds. After laser ablation of the microchannels on the plastic paper, a transparent poly (methyl methacrylate)(PMMA) film was thermally bonded to the plastic paper to enclose the channels. After connection of tubing, the device was ready to use. An example microfluidic device (droplet generator) was also fabricated using this technique. Due to the flexibility of the fabricated device, this technique can be used to fabricate 3D microfluidic devices. The fabrication process was simple and rapid without any requirement of cleanroom facilities.

1P1-043 **SYNTHESIS OF SCALABLE MICRODROPLETS WITH FLUID INSTABILITY OF SHEARING FLOW IN MICROFLUIDICS** **No.164**

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This paper reports a microfluidic reactor for synthesizing micro- and nano-droplets using fluid shearing instability of immiscible flow in mircochannels. Three factors, flow rate between the two inputs, spout geometry and surface tension are numerically studied. Based on the simulation, a device with the optimal parameters was fabricated and tested. Both computational fluid dynamics (CFD) simulation results and experimental results suggested that this technique is capable of conveniently controlling the droplets sizes from hundreds of micrometers down to several micrometers or even nanometers. This pilot research offers a proof of concept demonstration using instabilities in the microchannels to synthesize large quantity of microdroplets. Although the microdroplets in this study were formed by DI water containing Tween20 and silicon oil, the design with modification could be applied for synthesis of other types of micro- and nano-droplets.

1P1-044 **STUDY OF POLYMERIC MEMS MICRO-PUMP ACTUATED BY PZT BIMORPH** **No.166**

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Check valve micro-pump is easy to reach high flow rate and has a promising application prospect in micro fluidic devices and artificial organs. There are several vibration elements in check valve pump, including actuator, membrane and valves. The vibration performances of these elements have a coupling influence on the performance of micro-pump. In this paper, the comprehensive analysis was carried out using finite element model. Four kinds of micro-pumps with different valves and actuators were designed and fabricated. The performances of each kind of micro-pumps are studied by frequency sweeping experiments. Experimental results approximately coincide with the theoretical analysis.

1P1-045 **STUDY OF GENE TRANSFECTION ENHANCEMENT AND PARAMETERS OPTIMIZATION USING MICROFLUIDIC ELECTROPORATION CHIP** **No.181**

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We developed a simple fabrication, low voltage, low power consumption and easy way of enhancing gene transfection efficiency: combining high and low electric fields, adjusting the voltage, pulse number, duration, buffer and conductivity. The 293T cells (Human Embryonic Kidney cells) were tested. The optimum combining condition was a high electric field 1600 V/cm for 0.6 ms × 2 and low electric field 800 V/cm for 1.2 ms × 3. It resulted in a survival rate larger than 70%, and the transfection rate was about 45%. The buffer of the largest transfection rate was Hypoosmolar. The conductivity of the buffer was an important parameter, and the appropriate value was 1.0-3.6 mS/cm. The transfection rate of 293T cells using Cytoporation buffer could be enhanced by adding potassium ion, and the volume ratio should be lower than 2%.

1P1-046 **CNTs GATED NANOFLUIDIC SYSTEM FOR SINGLE BACTERIUM DETECTION BY GNPs-BASED REDOX SIGNAL AMPLIFICATION** **No.187**

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In this work, we report a portable microfluidic chip based on gold nanoparticle-enhanced electrochemical detection for single-bacteria diognostic. The possibility of single-bacteria detection is realized here by using electroactive molecules modified on gold nanoparticles (NPs) to detect and differentiate Staphylococcus aureus and Pseudomonas aeruginosa. The detection limit of these two electroactive molecules is near femtomolar (1 pM) when immobilized on gold nanoparticles (NPs), and the minima amounts of gold NPs required in the detection is around thousands (10^3 particle/μl). A concentration of couples whole bacteria (<10 cells/μl) is detected by CV measurements. The liner detection limit concention is form 1-1000 cells/μl. The results showed that the portable biochip system has great potential as a device for single-particle or possibly even single-organism detection.

1P1-047 **OPTIMIZED CAPILLARY BASED MICROARRAY USED FOR DNA ANALYSIS** **No.195**

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Microarray is an very useful tool for nucleic acid detection, but the procedure is labor intensive and time consuming. Microfluidic chip-based microarray saves time with better performance, whlie the low spot density and probe number limit its applications in many related fields. To develop high performance microarray with higher spot density and probe number, a method is reported here to prepare microarray in a capillary by generating probe droplets array. The probes in droplets are immobilized onto the inner wall of the capillary to form an one-dimensional probe array, and then a sample solution is introduced to hybridize with the probe array. This paper demonstrated the droplets array, probe array and hybridized spots array which were generated inside the capillary, then the cross contamination caused by the generation of droplets array was evaluated. Data showed that the cross contamination was only a very small portion. It can be regarded as the background and eliminated by subtracting.

1P1-048 **EXPERIMENTAL AND THEORETICAL STUDY OF HYDRODYNAMIC CELL LYSING OF CANCER CELLS IN A HIGH-THROUGHPUT CIRCULAR MULTI-CHANNEL MICROFILTRATION DEVICE ……No.231**

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Microfiltration is an important microfluidic technique suitable for enrichment and isolation of cells. However, cell lysing could occur due to hydrodynamic damage that may be detrimental for medical diagnostics. Therefore, we conducted a systematic study of hydrodynamic cell lysing in a highthroughput Circular Multi-Channel Microfiltration (CMCM) device integrated with a polycarbonate membrane. HeLa cells (cervical cancer cells) were driven into the CMCM at different flow rates. The viability of the cells in the CMCM was examined by fluorescence microscopy using Acridine Orange (AO)/ Ethidium Bromide (EB) as a marker for viable/dead cells. A simple analytical cell viability model was derived and a 3D numerical model was constructed to examine the correlation of between cell lysing and applied shear stress under varying flow rate and Reynolds number. The measured cell viability as a function of the shear stress was consistent with theoretical and numerical predictions when accounting for cell size distribution.

1P1-049 **ELECTRIC MANIPULATION OF DROPLETS IN MICROFLUIDICS ……No.248**

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Precharged droplets can facilitate manipulation and control of low-volume liquids in droplet-based microfluidics. In this paper, we demonstrate non-contact electrostatic charging of droplets by polarizing a neutral droplet and splitting it into two oppositely charged daughter droplets in a T-junction microchannel. Using numerical methods for two-phase flow coupling with electrostatics, for the first time, we performed parametric study to understand the mechanism of charging process. Moreover, cases (such as T-junctions with a notch, different sizes of droplets, and surfactants) were explored for practical applications. Finally, we demonstrated effective droplet manipulation in a sorting unit appending to the droplet charging.

1P1-050 **SIMULATION AND FABRICATION OF CAPILLARY-DRIVEN MEANDER MICROMIXER FOR SHORT-DISTANCE MIXING ……No.602**

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In this article, the micromixer with the planar design, short mixing distance, long-term high hydrophilic property and with power-free rapid fluid transport functions has been demonstrated compared with conventional syringe pump micormixers. The short-term capillary-driven micromixers with complex mixing structures have proven with large potential with the mixing ability and no power input advantages that it can be use in instant medical examination and medicine fabrication. Here, we have demonstrated the long-term capillary-driven meander micromixer with the planar design, short mixing distance, and rapid fluid transport functions. The contact angle measurement was made for verifying surface property of various materials and both glass and JSR are good candidates. The Glass-JSR-Glass capillary-driven meander micromixer can improve mixing efficiency up to over 95% at only 8 mm short distance.

1P1-051 **RESISTIVE SWITCHING MODEL FOR ELECTROLYTE-OXIDE-SEMICONDUCTOR (EOS) STRUCTURE ……No.279**

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We find that the Electrolyte-Oxide-Semiconductor (EOS) structure, which is utilized a lot in micro/nanofluidic devices, is not perfectly insulated as previously believed. There is a significant leakage current through the insulator, and the I-V relationship shows one-way conductivity like a diode. We build a model considering the implantation of ions under forward bias and formation of conductive filaments in the oxide layer. Samples with oxide layers of different thicknesses and various fabrication processes were tested to verify our hypotheses. This structure provides a simple means to fabricate half-fluidic diodes, and can be utilized for ion detection and current control in microfluidic devices.

1P1-052 **SIMULATION OF BACKWARD FACING STEP FLOW AT THE OUTLET MICRO-CHANNEL AND OPTIMAL DESIGN OF AMPEROMETRIC DETECTION CHIP ……No.290**

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In this paper, we discussed the vortex which cause by the step structure at the outlet of microchannel. When the thickness of boundary layer and the height of the channel are fixed value, the vortex area length was decided by Reynolds number. COMSOL Multiphysics simulations based on the turbulence model were performed to provide a better understanding of the Reynolds number and the length of vortex area in the compound structure microfludic amperometric detection chip. According to the simulation results, we discussed the value for the height of the microchannel and the thickness of auxiliary bonding layer, we determined the manufacture parameters and assembly process of the microfluidic chip. Furthermore through the simulation results discussion of the microfluidic properties, we described how to set experiment conditions for amperometric detection.

1P1-053 **DROPLET FORMATION IN A T-SHAPED MICROFLUIDIC JUNCTION USING PRESSURE-DRIVEN PUMPING ……No.302**

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Here we experimentally study how the droplet formation in a T-shaped junction varies as the inlets pressure change by using a precise pressure-driven pump. The droplet length (L) and its production frequency (f) are measured as a function of the inlet driving pressure ratio of the dispersed to continuous phase (Pw/Po), respectively. A minimum pressure ratio for generating drops is found to be approximate 0.55 in our experiments. Results are compared with those of a system driven by syringe pumps which can vary the ratio of volume flow rate (Qw/Qo). Significant difference in the variation of droplet size exists between these two driven approaches when varying the flow control parameters: droplet size is more sensitive to the inlets pressure ratio.

1P1-054 **MICROFLUIDIC DEVICES WITH THREE-DIMENSIONAL GOLD NANOSTRUCTURE FOR SURFACE ENHANCED RAMAN SCATTERING ……No.343**

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Rapid and sensitive chemical sensing using microfluidic device equipped with sterically-bulky three-dimensional gold nanostructure (Au3D) was demonstrated. Au3D was expected as surface enhanced Raman scattering (SERS) active structure. Au3D was fabricated by convective self-assembly known as "coffee-ring" of the mixed solution of gold colloidal nanoparticle and polystyrene latex particle. SERS measurements of a trace amount of 4,4'-bipyridine (4bpy) in aqueous solution were performed using Au3D in batch and flow format, and typical spectrum of 4bpy with enhanced peaks were immediately observed after dropping (batch) or injecting (flow). While detection limit was about 10 nM 4bpy in batch measurement, detection of further enhanced spectrum of 1 nM 4bpy was accomplished in flow measurement. We confirmed that Au3D was available for convenient SERS optofluidic measurement.

1P1-055 **AN EXPERIMENTAL INVESTIGATION OF MICRO PULSATING HEAT PIPES ……No.396**

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Si-based micro pulsating heat pipes (μPHP) charged with HFE-7100 were tested at several heating powers with two orientations, θ = 00 and 900. The width of the channel is 0.8 mm in a μPHP having uniform channels, and 1.0 mm or 0.6 mm in the other μPHP. The depth of each channel is 0.25 mm. The overall size of each μPHP is 60 mm × 10 mm × 1.25 mm. Both visual observation and temperature response of the present μPHPs at various conditions were performed. The performance was compared between two μPHPs having either uniform channels or non-uniform channels at difference heating powers. Results showed that both μPHPs could not start the pulsating two-phase flow in the channel of μPHPs as the μPHPs were operated horizontally at heating power ranging from 1 W to 7 W, except when the μPHP having non-uniform channels was tested at heating power of 7 W. Unlike the failure start-up for horizontal arrangement of μPHPs, μPHPs with a vertical arrangement shows a significant start-up phenomenon for both μPHPs with uniform and non-uniform channels due to the assistance in the start-up of both μPHPs arising from gravity force.

1P1-056 **COMPARATIVE STUDY OF PID CONTROL AND MODEL PREDICTIVE CONTROL FOR A MICROFLUIDIC ELECTROPORATION SYSTEM ……No.406**

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This paper describes a comparative study of two feedback control methods for a microfluidic electroporation (EP) system. The regulation of the transmembrane voltage (*Vm*) and nano-electropore radius (*r*) of HeLa cells on a micro EP chip was achieved using a linear Proportional-Integral-Derivative (PID) Controller and also Model Predictive Controller (MPC) based on the critical electric field for single-cell EP. Numerical simulations of static and dynamic responses of the two critical states, *Vm* and *r*, shows that feedback control can improve the cell viability and EP efficiency compared to open-loop (OL) system. The benefits and limitations of these two control methods for EP and possible future works have also been discussed.

1P1-057 **MICRO DIFFUSER-TYPE MOVEMENT INVERSION SORTER FOR HIGH-EFFICIENT SPERM SORTING …No.461**

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In this study, we propose a microfluidic device with a diffuser type chamber to differentiate the sperm velocity by gradually lowering down the flow speed in diffuser by gradually increasing the width of the channel. When the sperms' moving speed match the flow speed, the sperms tend to have the ability to flow against the stream, thus separating the sperms at different specific positions along the diffuser according to their motility becomes gentle and fast. Most of the motile sperm will stay in the expanding area and the non-motile sperms will drift to outlet. Different from the previous study we proposed in IEEE NEMS , 2012 , here we have three improvements: (1) Sperms can be separated in more detailed quality level. (2) Sperm will be more activated by passing through a dumb bell area than by the traditional methods. (3) The space in the device can accumulate large amount of sperms (~millions).

1P1-058 **DESIGN OF DETECTION ELECTRODE ON CONTACTLESS CONDUCTIVITY DETECTION IN CAPILLARY ELECTROPHORESIS MICROCHIP ……No.479**

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Contactless conductivity detection has attained great attention in the last decade in capillary electrophoresis. But contactless conductivity detection is restricted by its sensitivity, how to improve detection sensitivity has become the key of contactless conductivity. In this paper a novel extended model for the detection cell consisting of a network of resistors and capacitors is proposed according to the structure of contactless conductivity detection. The effect of the detector geometry on the sensitivity of contactless conductivity is studied. By simulation, the optimal parameters are obtained. Sandwich electrode structure was established to improve the performance of the detector and minimize the stray capacitance between the electrodes. Using the optimal electrode structure, the two peaks corresponding to K^+ and Mg^{2+} are clearly resolved with complete separation.

1P1-059 **USING THE NEWLY MICROFLUIDIC CHIP TO PRODUCE THE UNIFORM EMULSIONS WITH DIFFERENT CONCENTRATIONS ……No.552**

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The newly microfluidic chip successfully uses the micro-mixer and flow-focusing device to produce the water droplets with eleven different trypan blue concentrations, and applies these chitosan microparticles for encapsulating the magnetic nanoparticles. The sizes of these eleven types of water droplet with different trypan blue concentrations are uniform with a coefficient of variation less than 10%, and the chitosan emulsions with eleven different Fe_3O_4 nanoparticles concentrations are used for magnetic targets, and the chitosan microparticles size is ranged from 44 μm to 83 μm in diameter.

1P1-060 **THE STUDY OF THE ENHANCEMENT OF MICRO-VIBRATION-INDUCED HARVESTER BASED ON VAPOR IMPACTING ……No.155**

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With technology rapidly advance, the energy of demand is also with the greatly increased. Therefore, the development of new energy or energy harvesting attracts much attention. Our group has proposed an innovated micro heat pipe harvester based on the micro-piezoelectric vibration-induced power device. The deformation of the piezoelectric material by vapors impacting enables it to convert the vapor momentum to the power. In this paper, the purpose is to enhance the output of the micro heat pipe generator by the optimization of the vibration-induced device. A suitable cantilever beam combined with piezoelectric material is designed by multiphysics and genetic algorithm. The optimal geometry is found to approach its natural frequency. The experimental results show that the power improves about 293.38%. Through this study, the micro heat pipe generator will be practiced and approach the available usage.

1P1-061 **INORGANIC ELECTRET WITH ENHANCED CHARGE STABILITY FOR ENERGY HARVESTING ……No.159**

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We report a new surface treatment of inorganic electret materials which enhances the charge stability. Coating the surfaces with 1H, 1H, 2H, 2H - perfluorodecyltrichlorosilane (FDTS) makes the electret surface more hydrophobic which improves the surface charge stability under high humidity conditions. Thermal tests show that the thermal stability of charge in the inorganic electrets is also much better than that of polymer materials such as CYTOP. A demonstrator device with SiO2 electrets shows promising results for energy harvesting applications.

1P1-062 **THERMAL CONDUCTIVITY OF SINGLE-WALL CARBON NANOTUBES FILLED WITH WATER ……No.219**

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Thermal conductivities for single-wall carbon nanotubes (SWNTs) filled with water are calculated with non-equilibrium molecular dynamics (NEMD) simulation method. Simulation results demonstrate the thermal conduction for the tube filed with water is better than the pure nanotube at the same conditions. It is believed the translational movement of the water molecules along the tube axis helps carry energy from the hot bath to the heat sinks, which results in the increase of the thermal conductivities. In addition, with the introduction of the water molecules into the nanotube, the additional interaction between the carbon atoms and the water molecules provide extra channels for phonon transport, which further intensifies the energy transport along the nanotubes. The effects of the temperature variation and the tube length on the thermal conductivities are also analyzed in this paper.

1P1-063 **OPTIMIZATION OF THE MICRO CHANNEL LADDER SHAPE HEAT SINK ……No.223**

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The channel heat sink is in contact with the working fluid to remove the heat. But much channel will result higher pressure difference issue in the micro multi-channel heat sink. In this paper, a ladder shape channel (link between the parallel channel) is proposed to correct the problem of high pressure difference. The design of the link decreases the pressure difference for reducing the pump work of the micro multichannel heat sink. The purpose of this paper is to maximize the efficiency of the micro multi-channel ladder shape heat sink by using optimization design. An optimization method based on the genetic algorithm and COMSOL 3-D conjugated thermal-fluid model is applied to establish the optimal geometry parameters of the link. The results show that this heat sink design can improve the efficiency more than 43%. And the heat removal of the proposed device is significantly improved.

1P1-064 **LOW FREQUENCY PVDF PIEZOELECTRIC ENERGY HARVESTER WITH COMBINED d_{31} AND d_{33} OPERATING MODES** **No.242**

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This paper reports the design, test and application of a novel low frequency piezoelectric energy harvester. To achieve high output voltage at low frequency, both d_{31} and d_{33} modes of polyvinylidene fluoride (PVDF) are utilized in this device. Output voltage of the device are tested under different frequencies and accelerations. Rectifying bridge is used to reverse signals with negative signs and capacitors can be charged to light up a light emitting diode (LED).

1P1-065 **LOW FREQUENCY VIBRATION ENERGY HARVESTING FROM HUMAN MOTION USING IPMC CANTILEVER WITH ELECTROMAGNECTIC TRANSDUCTION** **No.317**

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This research aims as a proof of concept for a vibration energy harvester using human motion as the energy source. Human motion consists of burst of low frequency vibrational kinetic energy. The high acceleration burst is usually 1. 5 to 2 g when the foot strikes the ground and an ionic polymer metallic composite (IPMC) can be used to harvest this energy via two methods. The first method is via the bending of the IPMC causing the mobile cations to move and produces an output voltage pulse, hence capacitive transduction. Secondly, the IPMC in a beam form that resonate at the low vibration frequency due to its relatively low Young's modulus can scavenge additional secondary energy via external electromagnetic transduction to supplement the primary harvested energy via the IPMC capacitive transduction.

1P1-066 **IMPROVEMENT OF SOLID OXIDE FUEL CELL BY IMPRINTED PATTERNS ON EELECTROLYTE** **No.404**

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This paper reports an improved interfacial structure between electrode and electrolyte of Solid Oxide Fuel Cell (SOFC). We employed an imprint process to give fine patterns onto a ceramic electrolyte sheet. The imprint process is a powerful tool to transcribe nano- to micro-patterns on materials.In the present work, a sheet of ceramic compound material was prepared, and micro patterns were given on the sheet. After debinding and sintering, dense ceramic sheet with fine patterns were obtained. We prepared three kinds of electrolyte sheets with different surface patterns using this technique. After applying anode and cathode layers, the three fuel cell samples were assembled to test the cell performance. It was resulted that the finer pattern caused the best performance in the three samples.

1P1-067 **SIMULATION ANALYSIS OF TRANSIENT PIEZOELECTRIC PROPERTIES OF PVDF STRUCTURE FOR ENERGY CONVERSION APPLICATIONS** **No.452**

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Rapid development of wireless sensor networks and portable electronic devices calls for solutions to self-powered micro-systems. In this work, two models based on poly- vinylidene fluoride (PvDF) structures which convert mechanical energy into electric energy are studied via COMSOL Multi-Physics simulation. A series of time-dependent transient analyses are performed and it is found that strains and output voltages generally follow the changes of applied stresses when the frequency of the applied stress is at 1 Hz. With a fixed frequency, output voltage and short circuit current increase with applied strain and with a fixed strain, the current increases with the frequency while the output voltage remains relatively stable. The theoretical energy conversion coefficient is 14.4% for the cantilever model and 13.2% for the membrane model.

1P1-068 **RESEARCH ABOUT TOP ELECTRODE IMPROVEMENT OF ZnO NANOWIRES ARRAY NANOGENERATOR** **No.470**

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A novel method to fabricate the top electrode of ZnO nanogenerator is introduced in the article. Hydrothermal synthesis is adopted to grow ZnO nanowires array structure. And the sputtering process is employed as a simple fabrication method to form the top electrode. Scanning electron microscope (SEM) analysis has been carried out to identify different layers in nanogenerator. The energy harvesting experiment of the nanogenerator excited by ultrasonic wave has been complete as well in the research. Experiment results reveal that the maximum output voltage reaches about 0.23V.

1P1-069 **FABRICATION OF MEMBRANE-TYPED METAL MOULD WITH MICROSTRUCTURES AND APPLICATION FOR ROLLER IMPRINTING** **No.112**

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In this paper, we focus on the development of membrane-typed metal mould with microstructures for imprinting. This mould has several benefits including reusable, easy replaceable core, and low cost that strongly improves industrial values in microstructure mass production. The membrane-typed metal mould with a thickness of 60 μm can be attached to a level mould or a roller mould, and becomes a metal core for the polymer microstructure imprint for mass production of products over large surface area. Photolithography, electroforming, and grinding techniques have been integrated in order

to develop the membrane-typed metal mould in this research. It has been proven that the metal mould of micro pillars could be successfully fabricated. This metal mould was fabricated by precision electroforming technology that Ni-Co alloy was deposited on a photoresist mould, and further peeled off to attach onto a level mould. The hardness, stiffness and toughness of the Ni-Co alloy material core structure were sufficient and strong enough for reusable duration. The durability of this membrane-typed metal mould has been greatly enhanced. Furthermore, by applying roller assisted attaching mechanism, the interface between the mould and Ni-Co alloy core became more inseparable and flat. According to the experimental measurement results, the uniformity has been controlled between ± 5 μm. The reproducing accuracy of the polymer microstructures can also be effectively enhanced.

1P1-070 **PRINT-TO-PRINT: A FACILE FLEXIBLE MULTI-OBJECT PATTERNING PROCESS USING SUPERHYDROPHOBIC FILMS ……No.137**

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In this paper, we present a simple versatile printing-based method, referred to as Print-to-Print (P2P), to form multi-object micropatterns for potential biological applications, along with our recent efforts to deliver out-of-cleanroom microfabrication solutions to the general public. The P2P method employs only a commercially available solid-phase printer and reusable superhydrophobic films developed by us. The whole process does not involve any thermal or chemical treatment. Moreover, the non-contact nature of droplet transferring and printing steps can be highly advantageous for sensitive biological uses. Using the P2P process, a minimal feature resolution of 229μm has been successfully demonstrated. In addition, this approach has been applied to form biological micropatterning on various substrates as well as multi-object co-pattems on the commonly used surfaces. Finally, the reusability of superhydrophobic substrates has also been illustrated.

1P1-071 **INVESTIGATIONS OF SILICON WAFER BONDING USING THIN AL AND SN FILMS FOR HETEROGENEOUS INTEGRATION ……No.142**

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Metallic wafer bonding has emerged as a key technology for microelectronics and MEMS. The Si wafers with
Al metallization film on surface are bonded by applying Sn film as intermediate layer, aiming at the application of heterogeneous integration. Averaged shear strength of 9.9 MPa is realized at bonding temperature as low as 280℃ with bonding time as short as 3 minutes under the bonding pressure of 0.25 MPa. Interface microstructure and fracture surface analysis were carried out to understand the underlying mechanism.

1P1-072 **SURFACE TENSION-INDUCED HIGH ASPECT-RATIO PDMS MICROPILLARS WITH CONCAVE AND CONVEX LENS TIPS ……No.153**

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This paper reports a novel method for the fabrication of 3-dimensional (3D) Polydimethylsiloxane (PDMS) micropillars with concave and convex lens tips in a one-step molding process, using a CO_2 laser-machined Poly(methyl methacrylate) (PMMA) mold with through holes. The PDMS micropillars are 4 mm high and have an aspect ratio of 25:1. The micropillars are formed by capillary force drawing up PDMS into the through hole mold. The concave and convex lens tips of the PDMS cylindrical micropillars are induced by surface tension and are controllable by changing the surface wetting properties of the through holes in the PMMA mold. This technique eliminates the requirements of expensive and complicated facilities to prepare a 3D mold, and it provides a simple and rapid method to fabricate 3D PDMS micropillars with controllable dimensions and tip shapes.

1P1-073 **IN-LINE TESTING OF BLIND TSVs FOR 3D IC INTEGRATION AND M/NEMS PACKAGING ……No.169**

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An in-line testing procedure of blind TSVs is put forward in this study. Insulation integrity is chosen to determine the eligibility. It is to probe the upper end of two or more neighboring TSVs during the manufacturing right after the blind vias being formed. Finite element method simulation was used to illustrate the testing principle, and experimental test were carried out for validation. During the test, leakage current data between two blind vias is obtained and I-V characteristic curve is plotted. It can be determined whether or not the TSVs are qualified.

1P1-074 **FABRICATION OF SUB-WAVELENGTH STRUCTURES ON SILICON DIOXIDE ……No.171**

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Sub-wavelength structure (SWS) as an effective method to suppress reflection of silicon material for many years [1-2]. Recently, the SWS was also employed in a transparent material, and hence the properties of transmission can be measured [3]. This work we present a process combining nanosphere lithography (NIL) and reactive ion etching (RIE) to fabricate arrayed nanostructure on commercially available slide glass. In additionally, we deposited an Au film of 20 nm on the substrate surface to suppress the transmission in the infrared wavelength for application of insulated window.

1P1-075 **SN-RICH Au-Sn HERMETIC PACKAGING AT WAFER LEVEL AND ITS APPLICATION IN SPR SENSOR ……No.172**

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Sn-rich Au-Sn solder bonding has been systematically investigated for low cost and low temperature wafer-level hermetic packaging of high-end MEMS devices. The AuSn2 phase with the highest Vickers-hardness among the four stable intermetallic compounds of Au-Sn system makes major contribution to the high bonding strength. The maximum shear strength of 64 MPa and a leak rate lower than 1×10^{-7} torr·l/s have been obtained for Au46Sn54 solder bonded at 310 °C. This bonding method has been successfully used to package the SPR sensors, and dramatically simplifies the sensor structure and fabrication process. The bonding results indicate that the Sn-rich Au-Sn solder bonding has provided a reliable, low-cost, low temperature, wafer-level hermetic packaging solution for MEMS device and has potential applications in high-end compact biomedical sensors.

1P1-076 **FABRICATION AND MORPHOLOGICAL CONTROL OF ELECTROSPUN ETHYL CELLULOSE NANOFIBERS ……No.199**

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Ethyl cellulous (EC) fibrous films were fabricated via electrospinning from solutions with various DMF/acetone volume ratios and the hydrophobic properties were investigated. The morphology of electrospun EC films reveals a conversion from beads to uniform nanofibers by decreasing the DMF/acetone ratio. Pure DMF solution leads to bead structures while uniform nanofibers can be obtained from DMF/acetone ratio of 2/3. The fibrous surfaces of electrospun EC films greatly improve their hydrophobicity with the average water contact angles range from 138° to 151°, exceeding that of spin-coating film (59°). The highest contact angle (151°) was found on the bead-on-string films prepared from the solution with DMF/acetone ratio of 4/1. For this hydrophobic capacity, the electrospun EC films would broaden their applications in the fields of coating and encapsulation.

1P1-077 **IN-SITU MEASUREMENT OF ION ANGULAR DISTRIBUTION IN BULK TITANIUM DRIE FOR MODELING THE ETCH PROFILE ……No.201**

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The bulk titanium deep reactive ion etching (DRIE) enabled high aspect ratio structures and devices are promising for harsh and in vivo environments applications. An etching model is necessary for better profile control to acquire needed performance, in which a correct ion angular distribution (IAD) in chlorine plasma is crucial. In this paper, an overhang SU-8 structure is proposed to experimentally in-situ measure the IAD by analyzing the etching profiles. With these data, a profile evolution model is developed to predict the titanium DRIE process.

1P1-078 **FABRICATION AND THERMAL STABILITY CHARACTERIZATION OF RU ELECTRODE USED FOR HIGH POWER CONTACT RF MEMS SWITCH ……No.203**

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This paper presents the fabrication and thermal stability of the Ru electrode used for high power Ru-Au contact RF MEMS switch with microspring contact design. Here we develop a new process with bilayer lift-off and strain release layer to get the 3000 Å Ti/Au/Ru electrode with excellent smooth edge for high power handling and low loss. Furthermore, the thermal test at 400℃, 500℃and 600℃ over 1 hour has been done. Investigation of the surface with SEM and EDX shows that the electrode has a good thermal stability at 400℃, which is proper for high power handling.

1P1-079 **ANNEALING EFFECT ON THE STABILITY OF PLATINUM THIN FILMS COVERED BY SiO_2 OR SiN_x LAYER ……No.206**

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This study examined the crystal structure and the surface morphology between Pt and SiO_2 or SiN_x as a glue layer according to the annealing treatment. The thermal temperature make the surface morphology of the Pt films changed, and the characteristics of Pt thin film resistors under different annealing temperature also been changed. The resistance of the film will decrease after thermal treatment which the annealing temperature is lower than 480℃, and the resistor will increase sharply after annealing above 500℃. SiO_2 or SiN_x layers covered on Pt also have an effect on the characteristics of Pt thin films.

1P1-080 **SIMULATION OF IMPINGEMENT AND SPREADING OF MICRODROPLET ON NON-HOMOGENEOUS SOLID SURFACE ……No.207**

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This paper presents a numerical study on the impingement and spreading of a micro-sized droplet on a nonhomogenous solid surface. Based on the phase field method, the numerical model was implemented with finite element method (FEM). Dynamic contact angle, which is dependent on the droplet contact line velocity, was applied at the contact surface based on Blake's model and hydrodynamic model. A novel scheme to specify the contact line velocity based on the phasefield function gradient at the interfacial region has been implemented. Numerical results show that a high wettability

difference between two surfaces confines the spreading of an impinging micro-sized droplet. Surface wettability patterning can be applied to control the deposition and spreading of a jetted droplet to produce accurate micro-sized features in electronic circuits.

1P1-081 **SURFACE PROPERTY STUDY OF DIFFERENT PATTERNING SAPPHIRE STRUCTURES BY ICP-RIE ……No.215**

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In this paper, we demonstrate and compare the formation of ordered etching masks for submicron patterned sapphire through use of the nanosphere lithography and nanoimprint lithography methods. Both NSL and NIL were applied to produce the submicron honeycomb network and cone protrusion array structure on the sapphire surface as etching masks. The sequent ICP-RIE technique was applied to further etch the sapphire under the mask. Two types of submicron pattern were obtained on the substrate surface after the etching processes were completed. One type of substrate was the submicron hole array structure and another type was the cone array structure. The working pressure had a considerable effect on the shape geometry and etching rate. The contact angles of the untreated substrate and two differing patterned sapphire substrates were measured and compared. From the contact angle measurement results, we concluded that the protruded contact area dominated the hydrophobic or hydrophilic property.

1P1-082 **FUNCTIONAL SU-8-PET COMPOSITE MICROCHIP INCLUDING AU MICRODOT ARRAY FABRICATED BY LOW TEMPERATURE POLYMER BONDING ……No.235**

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Au deposited SU-8 microdots comprised SU-8-PET microchip using low temperature polymer bonding technology is developed. A fine microdot array (1μm×1μm×0.5μm dots with 2μm pitch in area of 50μm×5mm) is fabricated by electron beam lithography (EBL) using SU-8 as a negative tone resist. A microchannel structure is formed with UV patterned SU-8 on a glass substrate. The SU-8 structure is sealed with a PET film by low temperature silane coupling bonding (140℃, 1.5MPa, 5min). The proposed microchip is fabricated successfully without leakage and is applicable as a microchip electrophoresis.

1P1-083 **FABRICATION OF SILICON PIEZORESISTIVE PRESSURE SENSOR USING A RELIABLE WET ETCHING PROCESS ……No.238**

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Silicon-based piezoresistive pressure sensors are generally fabricated as a piezo-sensitive diaphragm by using MEMS technology and SOI wafer. Lots of innovations and improvements have been made for silicon pressure sensor to increase its performance and reliability. It is found that the quality of Si-Si bonding will directly affect the performing of SOI substrate removing processes. The main problem is that the etching liquid infiltrate into bonding interface from the defect position of bonding wafer edge, resulting in the damage and corrosion of bonding wafer. To solve this problem, the paper presents an etching fixture design for effectively protecting the bonding wafer edge. Experimentally, a SOI-Si bonding wafer with poor quality in bonding edge was used to fabricate the piezoresistive pressure sensors by using the etching fixture. The experimental results show the use of etching fixture did not damage the bonding wafer and made a nice removal of SOI substrate. The fabricated pressure sensors wafers are also presented.

1P1-084 **A NEW EXPERIMENTAL METHODOLOGY USING POINT DEFLECTION TO QUANTIFY RESIDUAL STRESS OF THIN POLYMER MEMBRANE MATERIALS IN MEMS DEVICES ……No.261**

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In this study, a novel methodology to measure the stiffness by point deflection of a flexible polymer layer suspended on liquid using a nano-indenter is presented. The measurement allows us to extract residual stress values of the polymer material using a simple analytical model. With this method, very low stress values can be obtained, of the order of 1MPa, with good repeatability. This method allows accurate mechanical behavior prediction and dimensioning of flexible membrane materials used in Microsystems devices.

1P1-085 **A PDMS/METAL-FILM PHOTO-MASK FOR LARGE-AREA CONTACT PHOTOLITHOGRAPY AT SUB-MICROMETR SCALE ……No.269**

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This paper report a new type of soft PDMS photomask apply to conventional photolithography process for fabricate sub-micro scale patterns with large area. This new type of soft PDMS photo-mask is made by soft PDMS material and with the embedded metal layer as an opaque layer. The incident light will selectively blocked by the opaque material, and others are guided by the convex PDMS structures to expose the PR layer. Due to its soft and

compliance property, this new photomask can from intimate contact with substrate and carry out UV exposure in photolithography and forming PR microstructures. It is particularly useful in patterning slightly cursed substrates such as sapphire wafers. In this work, a hexagonally close-packed array PDMS/metal-film photo-mask is applied to demonstrate this new type photolithography process, a hole pattern with minimal feature size of 400 nm and a high aspect ratio pillar structures with aspect ratio of 2.3 are successfully achieved in both 2" and 4" full scale sapphire wafer. The finite-element simulation is applied to reveal the energy distribution in the PDMS soft mask. This new type of soft photo-mask can be easily fabricated at a low cost and repeatedly used for sub-micrometer patterning, and has a great potential in future applications in LED industries.

1P1-086 **EFFECT OF PHOSPHORUS DOPING ON THE PERFORMANCE OF Au/Si INTER-DIFFUSION ……No.278**

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In this work, both phosphorus doped and undoped Au/Si contact structures were investigated by scanning electron microscope (SEM) and Rutherford backscattering spectrometry (RBS) analysis after annealing at 350 °C for 30 min. The effect of phosphorus doping on the performance of Au/Si inter-diffusion is discussed in this paper. The SEM image of the undoped Au/Si contact structure revealed that inverted pyramid-shaped diffusion outline formed at the contact interface after annealing due to the non-uniformity and anisotropy of Au/Si inter-diffusion. However, when the crystal Si substrate was heavily phosphorus doped by ion implantation, the inverted pyramid-shaped outline was eliminated and a smooth contact interface was obtained. In addition, RBS analysis showed that the average diffusion depths in both cases were nearly the same, which indicates the phosphorus doping can alter the anisotropy of Au/Si interdiffusion but has no significant influence on the Au/Si interdiffusion rate.

1P1-087 **RESEARCH ON PROGRAMMABLE CAPILLARY-FORCE SELF-ASSEMBLY NANOFABRICATION ……No.289**

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The capillary-force which is an extremely important force in the small objects is considered to be one of the most effective driving forces for the micro-nanoscale self-assembly. However, the process of capillary-force self-assembly is usually uncontrollable, which has prevented it from being used in the formation of specific nanoscale devices. In order to explore the fundamentals of capillary-force self-assembly, we analyzed the impact factors of nanostructures suffered by capillary-force and gave a typical general physical model. Then, we studied the complex structures fabrication method based on capillary-force self-assembly, and analyzed its characteristics and limitations. Finally, we proposed a new concept of programmable capillary-force self-assembly to achieve a reliable control of capillary-force, and thus form a new nanofabrication method.

1P1-088 **LASER ADDITIVE MANUFACTURING TECHNOLOGY IN TITANIUM 64 IMPLANT OF MICROSTRUCTURE FABRICATION AND ANALYSIS ……No.295**

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Laser additive manufacturing technology is very attractive for industry applications due to the characterizations of rapid manufacture, flexible parameters select, customize, and complex 3D object fabricate. In this article, an EOS M-type direct metal laser sintering (DMLS) system was used to manufacture for customized hip implant with an IPG fiber laser. The part building process takes place inside an enclosed chamber filled with argon gas to minimize oxidation powdered material. We are successful design and producing an implant of imitation bone microstructure in titanium alloy. From the SEM analysis image, an approximately 100% dense surface has be observed. The mainly composition of selective laser additive manufacturing product are acicular structure of alpha-phase titanium. X-ray diffraction patterns also are observed the alpha-phase and betaphase mixture. This customized hip implant is used to clinical application for replacement the golden retriever's femoral head, and it get good results. Imitation bone structure can promote the biocompatible of titanium material and bone.

1P1-089 **THREE DIMENSIONAL MICRO-MECHANICAL AND MICRO-OPTICAL DEVICES FABRICATED BY HOLOGRAPHIC TWO-PHOTON LITHOGRAPHY ……No.316**

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Holographic two-photon lithography (HTPL) is a high speed parallel laser fabrication technique inside photosensitive materials based on spatial light modulation and two-photon polymerization. In this paper, a femtosecond HTPL system was built and femtosecond laser beam was modulated to multi beams with spatial light modulator (SLM). The quantity and the distribution of the multi foci can be well adjusted according to our design. On this basis, parallel fabrication of high precision micro-mechanical and micro-optical devices, which has promising application in MEMS, micro-optics, micro-sensors and so on, was demonstrated. This technique will contribute to the industrialization of femtosencd two-photon polymerization (FTPP) in the foreseeable future.

1P1-090 **PDMS-CYTOP HYBRID STRUCTURE MICROWELL ARRAY CHIP FOR TOTAL INTERNAL REFLECTION FLUORESCENCE MICROSCOPY ……No.355**

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A microwell arrry device with a hybrid structure of amorphour perfluoroplymer, CYTOPTM, and polydimethylsiloxane (PDMS) which is specialized in total internal refllection fluorescence (TIRF) microscopy was developed. Since the CYTOP layer, whose refractive index is as same as that of water, is

sandwiched between PDMS and glass substrate, leakage of incident light is avoided. PDMS layer upon the CYTOP enables high aspect ratio structures and easy integration of microfluidic components. Since direct bonding of CYTOP and PDMS is difficult to achieve, a chemical bonding method using aminosilane coupling reagent and 3-Glycoidoxypropyltriethoxysilane was applied. The bond strength was about 0.74 MPa. 24 × 50 microwell array was fabricated and their optical properties was evaluated. Measured TIRF microscopy results shows no interfere with incident light under the conventionally used conditions.

1P1-091 **FABRICATION AND ANALYSIS OF THREE-DIMENSIONAL OBJECT USING LAYERWISE MANUFACTURING TECHNOLOGY** **No.361**

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Layerwise manufacturing technology exhibits a high potential in the field of rapid manufacturing, due to its capability to directly build up three-dimensional metallic components. In this research, we established a layerwise manufacturing platform having YLR 500 AC fiber laser and an enclosed chamber vacuumed to minimize oxidation powdered material. From relationship of laser power and scanning speed can observe the variation of weld width. It assists to find the suitable laser parameters for laser additive manufacturing at blue region. The morphology of titanium specimen was analyzed by SEM image examined, and some porous structure formed due to the surface tension and oxide effect. The result of mechanical strength of 366.16 MPa was proved to be smaller than common bulk material. The X-ray diffraction patterns of titanium specimen has higher crystallization from R(110), R(101) and R(200). We have successfully fabrication a three-dimensional object and analysis its material properties.

1P1-092 **FABRICATION OF SILICON NANOSTRUCTURES VIA SILVER CATALYZED CHEMICAL WET ETCHING** ... **No.368**

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Silicon nanostructures have been synthesized by silver catalyzed wet etching methods. A one-step method was used to produce nanowires array, and a two-step methods were used to produce nano-holes array. For the one-step method, silicon wafers were etched in hydrofluoric acid/silver salt mixture solution. While for the two-step method, firstly silver nanoparticles were formed through rapid thermal annealing of silver thin films. The temperature, duration of annealing and initial thickness of the silver film jointly determined the distribution and diameter of silver particles. In the next step, silicon nanostructures were created using silver catalyzed etching in hydrofluoric acid/oxidizing agent solution. The experiment confirmed that the final sizes of the nanostructures corresponded to the diameters of the silver particles, and the length of nanostructures correlated with the Ag catalyzed etching duration.

1P1-093 **DISCUSSION ON THE LAPPING AND POLISHING PROCESS OF 4H-SiC WAFER** **No.384**

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In order to achieve a high quality silicon carbide (SiC) film, the lapping and polishing process scheme was introduced in this paper. The ductile iron was utilized as lapping disc material, which can quickly thin the SiC wafer to the film of uniform thickness. After three-step lapping process, the thickness of the SiC wafer was reduced to 35 ± 4μm. In the process of polishing, a rough polishing and a fine polishing were studied by selecting suitable polishing liquid, polishing pad and parameters. The results show that the lapping and polishing procedure can realize large area and high quality SiC films: the film thickness, 30 ± 2μm and the surface roughness RMS, 0.69nm.

1P1-094 **IMPROVED ELECTRICAL CONDUCTIVITY OF PANI/PEO POLYMER VIA ELECTROSPINNING AND ITS APPLICATION AS NH_3 GAS SENSOR** **No.405**

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Higher conductivity of electrospun nanofiber mat was observed by four-terminal resistance measurement compared to polyaniline (PANI)/ Polyethylene oxide (PEO) film based on the same doping method. In order to improve conductivity of the blended polymer and guarantee its spinability in the meanwhile, the concentration of PEO with great molecular weight of 5,000,000 could be decreased to 0.10wt%. The influences of voltage, electrode-to-collector distance and flow rate as well as environmental humidity in electrospinning process on the nanofiber morphology were respectively discussed in detail. PANI/PEO nanofiber mat can be used repeatedly for sensing NH3 gas. The response time is as short as about 6s and it can recover in 6 minutes when exposed to air.

1P1-095 **SUPERHYDROPHOBIC SURFACE OBTAINED USING PYRAMIDAL PTFE FILM FABRICATED ON RIE ETCHED SILICON** **No.408**

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We have developed a surface texturing process using a polytetrafluoroethylene coating with a pyramidal structure for obtaining superhydrophobic surfaces. In order to investigate the hydrophobic properties of the surface, we measured the contact angle and roughness values. The calculated roughness

factor and root mean square roughness ranged from 2.47 to 2.6 and from 0.25 μm to 0.4 μm, respectively. The contact angle of a water droplet on the surface was greater than 150°; moreover, this angle was maintained for over 7 weeks. This observation implies that extremely low wettability is achievable on superhydrophobic surfaces.

1P1-096 **FABRICATION AND CHARACTERIZATION OF MICRO-STRUCTURED SUPERCAPACITOR WITH NICKEL ON POROUS COPPER ……No.413**

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This paper reports the fabrication method and characteristics of a three dimensional micro interdigital structured supercapacitor. The proposed capacitor was fabricated by using two porous Cu/Ni electrodes with ultra-high surface area. The porous electrodes were formed by using a negative photoresist KMPR for high aspect ratio structure and electroplating technique. The electrochemical performances of the fabricated supercapacitor were examined in 1M KOH solution by using the cyclic voltammetric (CV), chronopotentiometric (CP), and electrochemical impedance spectroscopic (EIS) techniques. It demonstrated the pseudocapacitive and stable charge/discharge behavior. A high specific capacitance of 201 mF/cm^2, a power density of 5.06 mW/cm2, and low series resistance of 2.5Ω were obtained.

1P1-097 **A TRANSFER TECHNIQUE OF STRESS SENSORS FOR VERSATILE APPLICATIONS ……No.418**

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This paper reports a transfer process of silicon stress and Pt temperature sensors for versatile requirements. Based on a 3μm thick BCB adhesive layer, a 1.6 mm × 1.6 mm donor chip with stress and temperature sensors, which are fabricated on the silicon-on-insulator wafer using standard MEMS process, is bonded on a target wafer. After the bottom silicon layer and the insulator SiO_2 layer of the donor chip are etched by XeF_2 gas and RIE technique, only about 0.2μm thick top sensor layer and 0.7μm thick aluminum layer used as conducting wires and pads are transferred onto the target wafer for the measurement of its in-plane stresses. Through the transfer process of stress and temperature sensors, the in-plane stresses of the target wafer caused by the fabrication processes or the package processes can be measured.

1P1-098 **DEVELOPING RNA APTAMER NANOPARTICLES AS DRUG CANDIDATES TARGETING GLUTAMATE ION CHANNELS ……No.603**

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In finding new therapy for some neurological diseases, such as epilepsy, stroke and amyotrophic lateral sclerosis (ALS), one potential therapeutic strategy is to develop inhibitors for the α-amino-3-hydroxy-5-methyl-4-isoxazole propionic acid (AMPA) receptors, a subtype of the glutamate ion channel receptors. This is because excessive activity of AMPA receptors leads to abnormal calcium influx into neurons, which in turn leads to cell death. In developing AMPA receptor inhibitors that are both potent and water soluble, we have used systematic evolution of ligands by exponential enrichment (SELEX) and successfully identified three classes of aptamers with nanomolar potency. To turn them into potentially useful drugs, we are loading these RNA aptamer molecules onto specialized gold nanoparticles (AuNPs) to facilitate aptamer delivery, its absorption and distribution *in vivo*.

1P1-099 **MICRO-CHAIN MODEL OF MAGNETORHEOLOGICAL FLUIDS BETWEEN TWO PARALLEL DISKS ……No.604**

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Digital holographic microscopy is presented in this study, which can measure the Magnetorheological fluids (MRF) in different volume percentage of particles and different magnetic field strengths. Based on the chain structure of magnetic particle under applied magnetic field, the relationships between shear yield stress, magnetic field, size and volume percentage of MRF in two parallel planes can be established. It has important theoretical significance for the design of optimized parameters and the manufacture of MRF. The results show the yield stress is directly proportional to the volume fraction and the magnetization of particles in the MRF. The theoretical model for yield stress of MRF is established and the variation tendency of shear strength in MRF with different material composition can be predicted by this theoretical model.

1P1-100 **NUMERICAL ANALYSIS OF CHARACTERISTIC OF GAS FILM BETWEEN SPIRAL-GROOVED DRY GAS SEAL FACES AT SLOW SPEED ……No.605**

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The paper considering the surface roughness of mechanical seal ring, thermal viscosity effect and gas slippage flow effect, the modified expansion average Reynolds equation which is in compressible fluid conditions presented based on the theories of both gas polytrophic process and gas lubrication so as to study the gas film viscosity and seal performance of the S-DGS. The obtained results show along with the increasing of rotational speeds, the surface roughness can add gas viscosity, increase the bearing capacity and stability, reduce leakage quantity; in contrast, slippage flow effect weaken the gas viscosity and recedes the bearing capacity and stability, increasing the leakage; the influence of surface roughness and gas slippage effect on gas viscosity and seal performance reduced as the film thickness increased, the gas viscosity and seal performance with film thickness would not be affected by micro-scale effects when film thickness is greater than 2μm.

Poster and Exhibition 2 (P2) : Poster Number 2P1-2P103 EII

13:00-15:00 Day2: Tuesday, April 9, 2013

2P1-001 **DESIGN AND FABRICATION OF VARIABLE MICROPATTERN FOR FLEXIBLE BACKLIGHT ……No.420**

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The effect of variable micropattern for an advanced compound optical film was investigated. This compound optical film was made by using Lithographie galvanoformung abformung (LIGA)-like process. The multi-step electroforming with micro-void embedded Polydimethylsiloxane (PDMS) was developed. This work presents many innovative processes, such as the homemade gray scale mask to fabricate variable size array; the multi-step electroforming process to fabricate various fill-factor from high to low and from low to high; and the embedded micro-void to fabricate optical film without substrate that avoids total internal reflection. FRED is a commercial software for optical simulation and design. The diffusion of the micro-void array and light guide of the variable size microlens array were discussed. Experimental results show that the variable size microlens array with embedded micro-void can be packaged flexible on side light emitting diode (LED) to improve its lighting uniformity and the light extraction efficiency.

2P1-002 **VIBRATION DAMPING PROPERTIES OF GRADIENT INTERPENETRATING POLYMER NETWORKS COMPOSED OF POLUURETHANE AND VINYL ESTER RESIN……No.422**

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Gradient interpenetrating polymer networks (IPNs) with the component sequences of polyurethane(PU) and vinyl ester resin(VER) of 60/40~70/30~80/20 and 70/30~80/20~90/10,cured at room temperature, were synthesized. The effects of time intervals and component sequences of gradient IPNs on their damping properties were studied by Dynamic Mechanical Analyzer (DMA). The maximum damping loss factors (tanδ) and the peak times of tan$\delta \geq 0.3$ in tanδ~T curves of different gradient IPNs were calculated and compared quantitatively. The extensional gradient IPNs was prepared at steel sheet with thickness of 1mm and the vibration damping properties were measured by the cantilever method with steel sheet as substrate and the gradient IPNs as coatings. The effects of the thickness ratio of the IPNs coatings and the substrate, the component sequences of the gradient IPNs on the structural loss factor (h) of the extensional damping structure at different resonance frequencies were studied.

2P1-003 **MECHANICAL STABILITY ANALYSIS OF ORGANIC THIN FILM TRANSISTORS CONSIDERING INTERFACIAL DELAMINATION ……No.433**

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State Key Laboratory of Digital Manufacturing Equipment and Technology, School of Mechanical Science and Engineering, Huazhong University of Science and Technology, China

It is shown that the organic thin film transistor (OTFT) device's failure during bending test is related with the interfacial delamination of the top-electrode in some recent studies. However,the mechanism of the OTFT interfacial crack occurrence is still not clear. Aiming at this problem, the OTFT interfacial crack of the top-electrodes in pure bending is studied and discussed using the finite element analysis, based on VCCT with dummy nodes in this paper. It is found that the edges of top-electrode, especially the channel side edges, have the maximal possibility to produce interfacial crack based on the peel and shear stress distributions in multilayer structure. The effect factors, such as the top-electrode thickness, material properties and substrate thickness, have also been considered in the discussion. It is shown that the thinner and tender source/drain electrode as well as the thinner substrate will help to improving the OTFT reliability.

2P1-004 **MICROMACHINED INDUCTOR INTEGRATED WITH A PATTERNED SOFT MAGNETIC THIN FILM ……No.477**

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This study demonstrates a novel design and fabrication process to realize micromachined inductor integrated with the patterned soft magnetic film (CoFeB). In order to enhance inductor's inductance and find out the major design parameters, three types of the inductor integrated with the patterned soft magnetic film was designed, fabricated and tested. The spiral type inductor was fabricated by copper electroplating. This novel approach to integrate inductor with soft magnetic thin film by depositing the nitride film dielectric layer for increasing the inductance. As a result, the influence of the soft magnetic film contributes 10 % increase in the inductance on "magnetic film aligned" inductor at 2 GHz.

2P1-005 **DRUG-LOADED CUBIC MICRO-CHAMBER MADE OF A BIODEGRADABLE POLYMER FOR BACTERIA-BASED DRUG DELIVERY ……No.498**

Hyung Jung Yoo, Sangmin Lee, Jae Hyun Ahn and Dong-il "Dan" Cho

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In this paper, a novel method of fabricating a drug-loaded, cubic micro-chamber made of biodegradable polymer for bacteria-based drug delivery is presented. A biodegradable polymer, poly-capro-lactone (PCL), is used to fabricate the micro-structure. The biocompatibility of PCL is approved by the Food and Drug Administration in U.S. for use in humans. To fabricate the drug-loaded cubic micro-chamber, laminated PCL films are prepared, and a drug is encapsulated between the films using the inkjet printing method. Generally, PCL cannot easy be micromachined by a conventional photolithography technique. Therefore, an x-ray lithography process is developed to fabricate the cubic structure. The fabrication results indicate that the proposed method is excellent for microfabricating drug-loaded cubic micro-chambers made of the biodegradable PCL for bacteria-based drug delivery.

2P1-006 **A NEW PZT MICROPUMP FABRICATED FOR CONVEYING FLUIDS ……No.516**

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In this paper, we designed and fabricated a new PZT micropump that could pump into and pump out fluids. This pump is consist of two parts: one chamber and two channels. Its mass and size are 1g and 10×10×1 mm respective. It can control tiny fluid movement per minutes. This device can connect hollow microneedles and be employed to deliver drugs. It also can be used as a micro-flow controller.

2P1-007 **SF_6 PLASMA ETCHING AND PROFILE EVOLUTION OF SILICON IN MICROPLASMA REACTOR ……No.521**

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Microplasma has been applied widely in microand nano-device fabrication. The etching performance and profile evolution are crucial for realization of Scanning Plasma Etching (SPE). In this work, silicon etching in SPE with microplasma reactor will be discussed through multi-fluid plasma model integrated with Monte Carlo model. The relationship between etching rate and tip-sample distance is discussed. The evolution of etched silicon profile is also investigated through simulation of feature diameter and etching depth with the time. The result of simulation will provide a foundation for optimization of operative conditions of SPE.

2P1-008 **BILAYER WIRE-GRID POLARIZERS FOR DUV TO IR FABRICATED USING EUV INTERFERENCE AND NANOIMPRINT LITHOGRAPHY ……No.532**

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We present the design of a bilayer metallic wire-grid polarizer (WGP) optimized for operation in the deep-ultraviolet (DUV) region, and their high-throughput fabrication of over large areas by nanoimprint lithography (NIL). The master imprint stamps were fabricated using our newly developed scanning exposure strategy with extreme ultraviolet interference lithography (EUV-IL). Optical measurements show that the fabricated bi-layer polarizer covers a broad spectral range, starting from wavelength of 280 nm. TM transmission of 50%, and an extinction ratio of 20 dB (102) were realized.

2P1-009 **SILICON WAFER MODIFICATION BY LASER INTERFERENCE ……No.543**

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This paper presents the study of silicon wafer modification by two-beam laser interference. In the work, two-beam laser interference was used to pattern single crystal silicon wafers for the fabrication of gratings, and different laser fluences and pulses were applied to the process in the air. The results were obtained from single laser pulse exposures with the laser fluences of 637mJ/cm^2, 780mJ/cm^2 and 1280mJ/cm^2. The role of multiple laser pulses was also investigated. In the experiment, the laser wavelength was 1064nm, the pulse duration 7-9ns and the repetition rate 10Hz. The results indicate that the laser fluence and number of pulses have to be properly selected for the fabrication of gratings using laser interference.

2P1-010 **AN ELECTROCHEMICAL MICROSENSOR BASED ON MOLYBDOPHOSPHATE COMPLEX FOR FAST DETERMINATION OF TOTAL PHOSPHORUS IN WATER ……No.102**

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This work mainly describes an electrochemical microsensor based on the reduction of molybdophosphate complex for fast determination of total phosphorus (TP) in water. Compared with the traditional methods for phosphate detection reported previously that used bulk electrodes, this microsensor responds faster, and can be applied to TP detection rather than merely phosphate. Calibration of phosphate has been performed with standard solutions prepared with KH_2PO_4 with pH adjusted to 1.0. The limit of detection (LOD) is 0.66μmol/L, and linear range is 1～500μmol/L. The sensitivity is -0.657 nA per μmol/L (R^2=0.994). Detection of TP was also carried out in digested TP standard solutions, and the results were consistent with the nominal value of phosphorus concentration.

2P1-011 **DEVELOPMENT OF A PIEZOELECTRIC POLYVINYLIDENE FLUORIDE POLYMER-BASED SENSOR PATCH FOR SIMULTANEOUS HEARTBEAT AND RESPIRATION MONITORING ……No.105**

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This study reports a piezoelectric polyvinylidene fluoride (PVDF) polymer-based sensor patch for simultaneous heartbeat and respiration detections. The principle is based on the piezoelectric sensing mechanism to detect the pulsatile vibrations, and periodical deformations on the chest wall of human body during heartbeats and respirations, respectively. In this study, the sensor patch with a structurally curved PVDF film was designed, and fabricated.The role of the curved structure designed to enhance detection signals, and the capability of the sensor to faithfully detect the heartbeats and respirations were experimentally evaluated. Results revealed that the sensor was proved to be able to generate the heartbeat and respiration signals which were in concordance with those based on a commercial electrocardiogram (ECG), and respiratory effort transducer,respectively. As a whole, this study has developed a PVDF- based sensor patch which was capable of monitoring the heartbeats and respirations with high fidelity. Other distinctive features include its small size, light weight, ease of use, low cost, and portability. All these make it a promising sensing device to monitor heartbeats and respirations either in medical centers, or home care units.

2P1-012 **HIGH PERFORMANCE OXYGEN SENSOR UTILIZING ULTRAVIOLET IRRADIATION ASSISTED ZnO NANORODS UNDER LOW OPERATION TEMPERATURE ……No.114**

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This paper presents a novel ultraviolet (UV) irradiation assisted nanostructured ZnO film for high performance oxygen sensing under a low working temperature.The UV irradiation greatly increases the number of the excited electrons to attract the high electron negativity molecule of oxygen. The response for detecting the oxidation gases can be achieved without using the high catalytic temperature. Nanorod ZnO structures with high exposing area are synthesized on a glass substrate with interdigital sensing electrodes utilizing the developed two-stage sol-gel and hydrothermal processes. An 80 mW LED with the emission wavelength of 370 nm is then used to enhance the sensing performance of the nanostructured ZnO film. Results indicate that the sensing performance of the nano ZnO oxygen sensor is greatly improved. The oxygen sensor can work at a low temperature of 50°C with the assist of UV exposure, which is much lower than the working temperature of typical solid state metal oxide sensors of around 350°C. The response of the UV-assisted ZnO film shows 4.66 times larger than the same film without UV exposure. The method developed in the present study provides a simple yet high performance method for oxygen sensing under low operation temperature.

2P1-013 **A MICRO ELECTROCHEMICAL SENSOR WITH POROUS COPPERCLUSTERS FOR TOTAL NITROGEN DETERMINATION IN FRESHWATERS ……No.115**

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A micro electrochemical sensor has been developed for total nitrogen (TN) determination in freshwaters. After the digestion process of water samples, nitrate was detected with the microsensor modified by porous copper-clusters and the concentration of TN was calculated by a portable electrochemical system. As the electrocatalyst material, copper was electrodeposited onto the working-electrode of the microsensor by cyclic voltammetry (CV) method and square-wave pulsating current (PC) method. It was found that copper layer fabricated by PC method was open porous and performed higher sensitivity in nitrate detection than that fabricated by CV method. Calibration in digested samples showed that microsensors modified by PC method had sensitivity of 7.3104 $\mu A/mgL^{-1}$ and limit of detection (LOD) of 0.1 mg/L for TN determination. Concentrations of TN in 7 samples from lakes and rivers were detected using the portable electrochemical system. The results were in agreement with the data obtained by standard TN measurement method.

1P1-014 **SOL-GEL FIBER-OPTIC ABSORBANCE SENSOR FOR GROUNDWATER CONTAMINANTS ……No.119**

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An evanescent wave fiber optic sensor for the detection of groundwater contaminants is developed. A 62.5 μm fiber core, 15 mm in length, was chemically etched and coated with 20 μm porous silica medium using sol-gel dip-coating method. This lower-refractive index medium causes the light beam to be transmitted by total reflection and the resulting evanescent wave produces a net flow of energy across the reflecting surface in the surrounding medium where it interacts with the surrounding environment. The power intensity of the solgel modified fiber is measured in the 1540 to 1600 nm spectral range. Various amounts of pure hexane and ethanol were used to examine the response of the sensor. A remarkable influence of the absorption of the evanescent waves in the sol-gel modified fiber for hexane and ethanol was observed.

2P1-015 **MEASUREMENT OF INTERNAL TEMPERATURE, FLOW AND PRESSURE IN MICRO-METHANOL-REFORMER USING MULTIFUNCTION MICRO-SENSORS ……No.123**

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Methanol has many advantages, such as safe for storage and transportation and low reforming temperature. Methanol can be use to provide hydrogen for fuel cell. In this research, the multifunction micro-sensors are integrated using the micro-electro-mechanical systems (MEMS) technology for the in-situ monitoring of temperature, flow and pressure within micro reformer. The multifunction micro-sensors are embedded inside the micro reformer successfully and the calibration curves of micro temperature, flow and pressure sensors are finished. In the future, the further temperature, flow and pressure data obtained demonstrate that operation occurred in the micro reformer.

2P1-016 **SIMULATION AND DESIGN OF MICRO PRESSURE SENSORS APPLIED TO MEASURE THE INTRACRANIAL PRESSURE** ……**No.128**

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This paper reports a micrometer level pressure sensor to measure the intracranial pressure (ICP). The sensor is based on the piezoresistive effect. The piezoresistive pressure sensor is simulated and designed by using nonlinear programming Optimizing and FEA tools. The sensor is fabricated by MEMS process. From tests, the sensor samples performances match up the design.

2P1-017 **MECHANICAL CHARACTERIZATION OF NANOWIRES BY PLANAR VIBRATION SENSOR** ……**No.129**

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Nanowires have attracted considerable interest as the nanoscale interconnects and as the moving elements of both electronic and electromechanical devices. The evaluation of nanomechanical property plays a significant role in the development of new nanowire-based devices. Recently, we are engaged in developing an easy method for nanomechanical measurement by using an in-plane-mode piezoresistive vibration sensor fabricated with less process cost and package difficulties. Theoretical analysis and simulation results suggested that the device is capable of high-sensitive and variety, and it is expected to evaluate mechanical properties of metallic or metallic oxide nanowires.

2P1-018 **AN ENERGY HARVESTING DEVICE MANUFACTURED USING THE COMMERCIAL 0.18 mm CMOS PROCESS** ……**No.130**

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This study investigates the fabrication and characterization of an energy harvesting device using the commercial 0.18 μm CMOS (complementary metal oxide semiconductor) process. Based on the thermoelectric method, the energy harvesting device converts thermal energy into electrical power. The energy harvesting device is constructed by 408 thermocouples in series, and each thermocouple is composed of p-type and n-type polysilicon strips. In order to increase the temperature difference in the hot and cold parts of the thermocouples, the hot part of the thermocouples is suspended to reduce heat sink. The experimental results showed that the energy harvesting device had an output voltage of 0.4 mV at the temperature difference of 15 K and an output power of 125 nW at the temperature difference of 15 K.

2P1-019 **PIEZOELECTRIC MEMS DEVICES AND ITS APPLICATION AS BIO-CHEMICAL SENSORS** ……**No.145**

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MEMS resonator exhibits extraordinary high sensitivity when used as bio-chemical sensor for detecting weight of specimen, adsorption of molecules, etc. by resonant frequency shift, in which piezoelectric transduction is effective to reduce power consumption for portable applications. However, the sensitivity is deteriorated by piezoelectric film due to its energy dissipation. This paper reviews our recent developed piezoelectric MEMS resonators, including cantilever actuated by PZT and detected by piezoresistive gauge, beam resonator actuated by PZT and detected by electrostatic sensor, disk/ring resonator actuated and detected by PZT, for the pursuit of high *Q*-factor,high resonant frequency, and better device sensitivity. The performance of each device was evaluated and investigated. The advantageous & weaknesses of above devices were discussed for application as bio-chemical sensors.

2P1-020 **A COMPARISON STUDY ON HYDROGEN SENSING PERFORMANCE OF Pt/MoO_3 NANOPLATELETS COATED WITH A THIN LAYER OF Ta_2O_5 OR La_2O_3** ……**No.154**

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In this work, we investigate how hydrogen sensing performance of thermally evaporated MoO_3 nanoplatelets can be further improved by RF sputtering a thin layer of tantalum oxide (Ta_2O_5) or lanthanum oxide (La_2O_3). We show that dissociated hydrogen atoms cause the thin film layer to be polarised, inducing a measurable potential difference greater than that as reported previously. We attribute these observations to the presence of numerous traps in the thin layer; their states allow a stronger trapping of charge at the Pt-thin film oxide interface as compared to the MoO_3 sensors without the coating. Under exposure to H2 (10000ppm), the maximum change in dielectric constant is 45.6 (at 260℃) for the Ta_2O_5/MoO_3 nanoplatelets and 31.6 (at 220℃) for the La_2O_3/MoO_3 nanoplatelets. Subsequently, the max.sensitivity for the Ta_2O_5/MoO_3 and La_2O_3/MoO_3 based sensors is 16.8 and 7.5, respectively.

2P1-021 **A TWO-DIMENSIONAL SILICON-ON-GLASS ACTUATOR WITH DISPENSED POLYMER MICROLENS** ……**No.156**

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Significant advances in the technical capabilities of microlens actuators for optical pickups have been achieved using MEMS technology, enabling miniaturization and integration of optical data storage systems. In this work, a new type of compact silicon-on-glass (SOG) actuator for two-dimensional

(2-D) positioning of a dispensed polymer microlens is developed by MEMS technology. A wafer-level process for fabrication of the SOG actuator is achieved using anodic bonding of a pyrex wafer and an ultra-thin silicon wafer. Dispensed polymer microlenses are subsequently integrated onto the 2-D actuator. Typical displacements of about ±28.6μm in tracking direction and 3.2μm in focusing direction are experimentally characterized. The compact 2-D SOG actuator can simplify the assembly and expand the application area for the optical pickup system.

2P1-022 **FABRICATION OF SILICON NANOPILLARS ARRAY FOR DEVELOPING PCs SENSOR ……No.170**

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This study proposed the use of combined nanosphere lithography (NSL) and photo-assisted electrochemical etching (PAECE) to generate arrayed nano-pillar with high aspect ratio on silicon wafer, and then used for the application of photonic crystals (PCs) Sensor. The experiment result indicates the NSL can conveniently define nano-array and PAECE technique can effectively yield nano-pores and nano-pillars. The nano-pore, depth of 2.3μm and diameter of 90 nm, was generated by 1 V PAECE. When the bias of PAECE was enlarged to 2.2 V, nano-pillar array was produced with 2 μm in height, 100 nm in diameter and 20:1 for aspect ratio. The PCs sensor detection platform was composed by laser of 1550 nm, precision translation stage and polarimeter. Through this high sensitive system, we can examine the small bio-molecules of plasmid by means of the polarized variation represented in Poincarè sphere coordinate system.

2P1-023 **A MICROMACHINED MONOLITHIC 3 AXIS ACCELEROMETER BASED ON CONVECTION HEAT TRANSFER ……No.173**

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In this paper, a monolithic 3 axis thermal accelerometer has been developed based on standard CMOS process. This 3 axis thermal accelerometer use exactly the same sensor area and manufacturing process as 2 axis thermal accelerometer reported in the past. It is easy to mass produce and has low cost, small size.

2P1-024 **DESIGN OF LC-TYPE PASSIVE WIRELESS MULTI-PARAMETER SENSOR ……No.175**

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This paper presents an innovative design of miniature LC-type passive wireless multi-parameter sensor. The sensor consists of multiple planar inductors on a single substrate and variable capacitors forming resonant LC tanks with separated resonant frequencies. The multiple parameters of interest could be remotely measured by tracking the changes in the peak frequencies of the impedance phase at an external readout coil which is magnetically coupled to the sensor. In order to make sure that the discernible peaks can be observed, the partly-overlapped planar embedded inductors in a multi-layer organic substrate are used and respectively in parallel connected with MEMS variable capacitors. The sensor in this stacking configuration achieves multi-parameter telemetry without any significant increase in size compared to the previous single parameter counterpart. EM simulation and tentative experiments both have been carried out, and the results validate the proposed design.

2P1-025 **SIMULATION OF THRESHOLD VOLTAGE ADJUSTMENT BY B^+ IMPLANTATION FOR PMOS-RADFET APPLICATION ……No.177**

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pMOS-RADFET (radiation field-effect transistor) as micro-dosimeter has been widely applied in spacecraft, medicine and personnel dosimetry. Thick gate-oxide and zero threshold voltage (V_{th}) are two critical factors to achieve high performance pMOS-RADFET. In this paper, the Vth adjustment techniques for thick gate oxide by B^+ implantation are simulated systematically by Silvaco TCAD, including implanting energy, dose and anneal-ing conditions. And the impurity distributions both in gate-oxide and silicon substrate are analyzed. The results show that implant-ing energy up to 130keV and dose as 3.2e11 works well for 388nm gate-oxide. Considering activation and distribution of impurity, both annealing temperature and time has to be as low and short as possible.

2P1-026 **NOVEL FLEXIBLE ROOM TEMPERATURE NO_2 GAS SENSOR BASED ON POLYPYRROLE COATED SNO_2 NANOPARTICLES ……No.178**

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In this paper, we demonstrate a novel flexible gas sensor based on polypyrrole (PPy) coated SnO_2 nanoparticles that can be employed to detect low concentrations of NO_2 (0.5 - 5 ppm) at room temperature. This low-cost, easy-fabrication and wearable gas sensor was fabricated on PET substrate. The sensitive film was formed by first drop casting the solution of SnO_2 nanoparticles and $FeCl_3$ on the as patterned interdigital electrodes on PET substrate; then the substrate was exposed to saturated pyrrole vapor for 3h to obtain PPy coated SnO_2 sensitive film. Our sensor shows good performance in detecting low concentration NO_2 and the estimated detection limit is about 100 ppb at room temperature.

2P1-027 **FABRICATION OF AN AMMONIA MICROSENSOR BASED ON ZINC OXIDE** **No.179**

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The ammonia microsensor is fabricated by the 0.35 μm complementary metal oxide semiconductor (CMOS) process. The sensor is composed of a sensitive film and polysilicon electrodes. Area of the ammonia microsensor is about 1 mm^2. The sensitive film of the ammonia microsensor is zinc oxide prepared by hydrothermal method. The sensor requires a wet etching process to remove the sacrificial oxide layer and coats the zinc oxide sensitive film on the polysilicon electrodes after the CMOS process. The ammonia microsensor is resistive type. When the sensitive film absorbs or desorbs ammonia gas at room temperature, the sensitive film generates a change in resistance. Experimental results present that the sensitivity of the ammonia microsensor is about 12.6 Ω/ppm at room temperature.

2P1-028 **ZnO NANOPARTICLE AS THE SENSING ELEMENT FOR THE LOW-COST ACCELEROMETERS APPLICATIONS** **No.183**

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In this research, the ZnO nanoparticles have been used as the strain gauge element, which was applied as the embedded sensing element for the low cost accelerometers. The resistance, capacitance and impedance responses of the ZnO nanoparticle films to the external strain and acceleration, with different nanoparticle density and sizes (5nm, 10nm, 20nm) of ZnO nanoparticle were systematically studied. The maximum capacitance sensitivity of accelerometer can be up to 0.484 pF/g. The linearity is up from 99.219% to 99.549% as the densities increase. This research result showed that ZnO nanoparticles have the potential applications as the sensitive unit to develop the low cost and high sensitivity accelerometer in the future.

2P1-029 **A HIGH SENSITIVITY MICROMACHINED ACCELEROMETER WITH AN ENHANCED INERTIAL MASS SOI MEMS PROCESS** **No.202**

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This paper provides an enhanced inertial mass SOI MEMS process for the fabrication of a high sensitivity micromachined accelerometer. In the proposed process, the handle layer of the SOI wafer is used as an enhanced inertial mass, in this way, the inertial mass of the accelerometer can increase 5-15 times. Therefore, the sensitivity of the MEMS accelerometer can be significantly increased. In this paper, an in-plane single-axis accelerometer is designed firstly. And then, the accelerometer is fabricated in a low resistivity SOI wafer with 60μm thickness device layer and 400μm thickness handle layer through the developed enhanced inertial mass SOI MEMS process. The sensitivity of the fabricated MEMS accelerometer is 2.257V/g, the linearity of output is within 0.5%, and the power spectral density of the noises is as low as 6.79μV/$\sqrt{Hz}$.

2P1-030 **A Si-GLASS BASED PRESSURE SENSOR WITH A SINGLE PIEZORESISTIVE ELEMENT FOR HARSH ENVIRONMENT APPLICATIONS** **No.205**

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A Si-Glass based MEMS piezoresistive pressure sensor is designed for harsh environment applications, such as vibration, shock and environment conditions with humidity, alkalescence or acidity, electrostatic particles and so on. The sensor chips were fabricated using SOI wafer-glass anodic bonding technology, which enables a single boron-implanted piezoresistor to be on lower surface of silicon diaphragm and be vacuum-sealed in glass cavity. The sensing signals were led out by using the embedded Al electrode structure at the bonding interface of Si-glass to connect single piezoresistor, and two large-area Ni-Au pads are used to electrically connect to the print circuit board (PCB) by using the drag soldering technology instead of gold wire bonding. The characteristics of voltage-pressure were measured with constant current under different temperature conditions. A temperature compensation technology is used to calibrate the measured results, by which the sensitivity of 116 mV/ (mA•MPa) and accuracy of 5.8% F.S. are obtained.

2P1-031 **PHOTOCATALYTIC MICROREACTORS FOR WATER PURIFICATION: SELECTIVE CONTROL OF OXIDATION PATHWAYS** **No.212**

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This paper analyzes the different reaction pathways that play major roles in the process of photocatalytic degradation, and presents a novel microfluidic photoelectrocatalytic reactor for selective control of them. This is accomplished by applying positive or negative bias potential to the photocatalytic reaction chamber and to select either the hole-driven or electron-driven oxidation pathway. The experimental results show that the negative bias exhibits higher performance in degrading the model chemical of methylene blue. Such selective control brings several important benefits. It provides another degree of freedom for photocatalysis, and enables detailed kinetic study on the reaction mechanisms. And, the bias eliminates the electron/hole recombination, which is one of the fundamental limits in conventional photocatalytic systems. In additional, the experiment shows that the bias produces a synergetic effect of electrocatalysis and photocatalysis and significantly enhances the degradation efficiency. The photoelectrocatalytic microreactor shows high stability and may be scaled up for high-performance water purification.

2P1-032 **ELECTROSPUN NICKEL OXIDE NANOFIBERS FOR GAS SENSOR APPLICATION ……No.216**

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Oxide gas sensor based on electrospun nanofibers were fabricated and studied in this paper. Polyvinyl pyrrolidone (PVP)/Nickel acetate precursor nanofibers were electrospun, which were sintered into Nickel oxide (NiO) nanofibers with diameter in the range of 100 to 400 nm. The morphology and structure of NiO nanofiber were characterized by scanning electron microscopy and X-ray diffraction. The Gas sensing properties (C_3H_6O,C_2H_5OH and NH_3) of NiO nanofibers were also investigated. The NiO nanofibers exhibited rapid response/recovery sensitivity with all the three target gases at room temperature. The response/recovery time of electrospun NiO nanofiber gas sensor for C_3H_6O, C_2H_5OH and NH3 were 4/5.5s, 2.5/2s and 16/5s; and the sensitivity were 11.0, 15.9 and 72.3, respectively. These results suggest that the electrospun NiO nanofibers are promising for gas sensor applications.

2P1-033 **INFLUENCE OF SUBSTRATE SURFACE ROUGHNESS ON THE PROPERTIES OF A PLANAR-TYPE CO_2 SENSOR USING EVAPORATED Li_3PO_4 FILM ……No.220**

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Planar-type potentiometric CO_2 gas sensors using thermal evaporated Li_3PO_4 thin film as the solid electrolyte were fabricated. Al_2O_3 plates with rough and smooth surfaces were used as the substrates of the sensors. X-ray diffraction analysis, atomic force microscope and scanning electron microscope were used to characterize the Li_3PO_4 films. The sensing properties were investigated in the range of 500~5000 ppm CO_2 concentrations at 480 °C. Both the rough substrate sensor (r-sensor) and the smooth substrate sensor (s-sensor) showed a good Nernst behavior. The output EMF of s-sensor showed a more stable signal than the r-senor. Response and recovery times of the r-sensor were 40 s and 75 s, and for the s-sensor they were 35 s and 60 s. The ΔEMF/decade values obtained from the r-sensor and s-sensor were 45 mV/decade and 55 mV/decade, respectively. It can be found that the Nernst's slop of the s-sensor was closer to the theoretically value. The results revealed that the substrate surface roughness may influence the characteristics of Li_3PO_4 film and the response properties of the sensors to CO_2.

2P1-034 **MULTI-CHANNEL MICROELECTRODE ARRAY FOR CORTICAL RECORDING AND STIMULATION: FABRICATION AND MODIFICATION ……No.225**

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The fabrication of silicon-substrate multi-channel microelectrode arrays for single neuron recording as well as modification of two materials to optimize the neural tissue-electrode interface were investigated. By use of multi-project wafer (MPW) model, six kinds of microelectrode arrays with different recording sites arrangement were simultaneously fabricated from one 4-inch wafer. To improve electric characteristic and biocompatibility, conducting polymer poly(3,4-ethylenedioxythiophene) (PEDOT) and multi-wall carbon nanotube (MWCNT) were used to modify the surface of microelectrode. The modified microelectrode exhibited better electrochemical characteristics, including a particularly high safe charge injection limit and low electrode impedance, as well as high signal-to-noise ratio *in vivo*. All of these characteristics are desirable for an implantable neural microelectrode and the modification method can be widely used to modify other neural interface devices.

2P1-035 **COMPRESSIVE SENSING OF NEURAL ACTION POTENTIALS USING NANO PLATINUM BLACK MODIFIED MICROELECTRODE ARRAY ……No.240**

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Long-term wireless neural recording systems which are subject to stringent power consumption, are highly desired to reduce the rate of data transmission and computation complexity. In this paper, we propose using a combination of on-chip neural action potentials ('spikes') detection system and compressive sensing (CS) techniques to reduce the power required for data transmission and a random Bernoulli matrix to reduce the computation complexity consequently further reduce the power consumption. By analyzing the data detected by nano platinum black modified microelectrode array implanted in the hippocampus of the Sprague-Dawley (SD) rat, we prove that spikes are compressible in the wavelet domain. We use the Bayesian CS algorithm to reconstruct them. Our results show that the mean compression ratio is 26:1 achieved for 16-dB SNDR recovery using this mechanism.

2P1-036 **A NOVEL PLANAR MICROELECTRODE ARRAY FABRICATED FOR BRAIN SLICE ELECTROPHYSIOLOGY ……No.241**

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To provide an effective and widely applicable tool for electrophysiological experiments of acute hippocampal slices, a novel planar microelectrode array (pMEA) was fabricated by standard photolithography technology. The novel pMEA has a special distribution of microelectrodes, with the nano-structure interfaces, the low impedance and superior signal-to-noise ratio characteristics. It could be directly applied to the electro-physiological experiments for different regions of acute hippo-campal slices from rat brains. The electrophysiological signals from the CA3 and CA1 regions of an acute hippocampal slice were successfully recorded by the novel pMEA in this article.

2P1-037 **ELECTRICAL PROPERTIES OF MICRO-HEATERS USING SPUTTERED NiCr THIN FILM ……No.254**

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NiCr (80/20 at.%) thin films were deposited on SiO_2/Si substrates as a cryonetic heater by DC magnetron sputtering technique. After a series of annealing treatments under various conditions, the electrical properties and microstructure of the films were investigated. The crystallinity and composition of the films were analyzed by X-ray diffraction (XRD) and scanning electron microscopy (SEM). The films are changed from crystalline to amorphous phase after annealing at 250 ℃ in nitrogen ambient and the annealing conditions have a significant effect on the resistivity and temperature coefficient of resistance（TCR） of the films. TCR of the samples annealed at 250 ℃ for 9 minutes in N2 shows 9.23 ppm/K at 20K which is finally confirmed as the optimal result.

2P1-038 **A DUAL MODE NEURAL SIGNAL RECORDING SYSTEM FOR SYNCHRONOUS NEUROELETRICAL AND NEUROCHEMICAL DETECTION ……No.255**

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This paper presents a 64-channel Dual Mode Neural Signal Recording System (DMNSRS) for detection of neuroeletrical and neurochemical signals. The DMNSRS comprises neurochemical recording module with current resolution of 1 pA and neuroelectricity recording module with voltage resolution of 0.3 μV. The two modules can work synchronously without mutual interference. In a global cerebral ischemia experiment, using Multi-Electrode Arrays (MEA) as neurobiological electrode and a single-walled carbon nanotube (SWNT)-modified glassy carbon electrode as neurochemical working electrode, the neuroelectrical and neurochemical signals are synchronously recorded by the DMNSRS in the Sprague-Dawley (SD) rat cortex.

2P1-039 **MAGNETICALLY ACTUATED RESONANT PIEZORESISTIVE MICROCANTILEVER OPERATING IN FLUID FOR DC CURRENT MEASUREMENT ……No.260**

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A novel dc current sensor based on magnetically actuated resonant piezoresistive microcantilever is proposed. The sensor measures the dc current by detecting the shift of resonant frequency of the microcantilever. A detailed theoretical study on the relationship between the current and the cantilever's resonant frequency is also given. To reduce force and displacement noise, the microcantilever works in the fluid with good thermal conductivity. The experimental results show that the sensor can achieve a sub-milliampere resolution and the accuracy is found to be 3.93% for the current of 0.5 to 5 mA.

2P1-040 **FABRICATION AND CHARACTERIZATION OF A NOVEL MULTI-ANNULAR TYPE BACKSCATTERED ELECTRON DETECTOR FOR SEM ……No.265**

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A novel silicon PIN diodes for detecting backscattering electrons in SEM was proposed and fabricated. The multi-annular configuration enables to provide better surface topography contrast of BSE image compared with traditional quadratic configuration. In this study, the multi-annular backscattered electron detector (BSED) can provide surface topography contrast of 82.11 nA/μm, which is 105% increase as compared with commercial BSED. Besides, the multi-annular detector has lower threshold detective energy of 1.28 keV and wide detective dynamic range (up to 30 keV). It is demonstrated that the multi-annular BSE detector is well suited for imaging in SEM system.

2P1-041 **AN INTERFACE ASIC OF QUARTZ VIBRATORY GYROSCOPE WITH 0.8°/HOUR ROOT ALLAN VARIANCE ……No.266**

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This paper analyzed the factor of bias drift of quartz vibratory gyroscope, proposed improving bias stability of quartz vibratory gyroscope and designed an interface ASIC of quartz vibratory gyroscope. The bias instability is generated by characteristic of noise in the detecting circuit and the quantity of the driving single in the exciting circuit. We propose a sine-wave exciting circuit which has lower phase noise than the traditional exciting approach. An operational amplifier with low noise and offset voltage temperature coefficient is designed to decrease the bias instability. The interface ASIC integrated on a 5×4.4mm^2 chip with 0.5μm CMOS process has 40mW power supply, 18nV/Hz$^{1/2}$ equivalent input noise density, and 0.8°/hour root Allan variance.

2P1-042 **A MULTI-CHANNEL TEST SYSTEM FOR CALIBRATION OF MEMS BAROMETRIC PRESSURE SENSORS …No.271**

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For the advantages of small volume, low power consumption and high accuracy, MEMS sensors have been widely used in many fields, especially for

high altitude meteorology monitoring, where a radiosonde with MEMS barometric pressure sensors will be used to collect the data of barometric pressure. Therefore, the way to calibrate such MEMS sensors effectively is of a great value. This paper reported a method for calibration of multiple state of the art MEMS barometric pressure sensors simultaneously based on an innovative test system. With this system, at most eight sensors can be calibrated in a same time. A test by utilizing BMP085 has been implemented, and the results showed that the system was reliable and effective.

2P1-043 **RESEARCH ON THE STRUCTURE OF ULTRATHIN Si PIN DETECTOR ……No.311**

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Ultrathin PIN Detectors have been applied in radiation detection for particle identification and etc. In this paper, we present simulation research on the structure of ultrathin Si PIN detector based on bonding technology by using Sentaurus TCAD tool. The normal structure and reverse structure of ultrathin Si PIN detector are simulated and compared. The reverse current of detector and electrical field distribution are analyzed. It is found that the reverse current of the reverse structure increases fast when the voltage exceeds a threshold value. It is explained by considering the parasitic MOS structure. This effect can be reduced by increasing the thickness of buried SiO_2.

2P1-044 **COMPACT MULTI-LAYER MAGNETIC SHIELDS FOR CHIP-SCALE ATOMIC DEVICES ……No.318**

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We have designed four sets of multi-layer nested magnetic shields. External diameters for the individual shielding layers range from 3.3cm to 5.3cm. The four sets of magnetic shields are tested by fluxgate magnetometer separately. The result of experiment is in excellent agreement with theoretical calculations. The four sets of multi-layer compact magnetic shields made of high-permeability material are compared. The largest shielding factor measured was 32.3 dB for a nested set of three cylinders (Set 2). The nested two spheres structure (Set 4) has the largest uniform region (12mm). The nested one shell of sphere and one cylinder shell (Set 3) achieve the best trade-off between uniform region and shielding factor.

2P1-045 **THREE DIMENSIONAL COMPENSATION SPHERICAL COILS FOR COMPACT ATOMIC MAGNETOMETERS ……No.320**

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To avoid the broadening of Zeeman resonances of the vector atomic magnetometer working in an unshielded environment, the rapid and accurate magnetic compensation is necessary. A three dimensional mini spherical compensating system is presented, which can be used together with a chip-scale atomic magnetometer to realize an ultra-high precision field measurement. Based on the field gradient method, parameters are optimized to obtain a uniformity of 10-3 over the region of one half radius with a good tolerance on dimensional variations. A prototype applied in the single laser beam scheme has been built and the experimental results demonstrate the validity of the design.

2P1-046 **DESIGN, SIMULATION AND FABRICATION OF A MICROMACHINED CANTILEVER-BASED FLOW SENSOR ……No.328**

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A micromachined cantilever-based flow sensor is designed, depending on the detection of surface strain on the cantilever caused by the mass flow. In the continuous flow mode, the deflection of cantilever is directly proportional to the flow rate. The working mechanism of the strain beam in the flow sensor is analyzed, and the finite element method(FEM) is used to investigate the structural deformation and stress distribution, and the FLUENT is used to analysis the coupling characteristics between the fluid and solid. According to the simplified stress analysis and simulation results, the flow sensor has a sufficient structural strength within its measure range of 10 to 200ml/min, and will achieve ideal static characteristics that meet the requirements of practical applications. By varying the design of the cantilever, the measurement range and sensitivity of the sensor can be changed.

2P1-047 **APPLICATION OF MICROMACHINED QUARTZ TUNING FORK RESONATOR FOR TEMPERATURE SENSING ……No.360**

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This article describes a micromachined quartz tuning fork resonator, 6 mm in height by 2 mm in diamter, holding a two-terminal electronic component with a nomial frequency of 36 kHz (at zero degree) and 15 pF typical capacitance paked in a 90 Pa He gass sealed metal container, which has been used as a sensor for temperature measurement with good sensitivity, repeatability and reliability. The temperature sensor is ZYtw-cut-quartz crystal bulk acoustic wave resonator vibrating in a flexural mode. Finite element method is used to analyze the vibratory modes and optimize the structure of the sensor. Design and performance analysis of the quartz tuning fork temperature sensor has been conducted. The sensor prototype was successfully fabricated and calibrated in operation from 0°C to 100°C with sensitivity of 80ppm/°C.

2P1-048 **PHOTOCATALYTIC DIGESTION OF TOTAL PHOSPHORUS IN THE PRESENCE OF H_2O_2 UTILIZING NANO-TiO_2 PHOTOCATALYST** **No.363**

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In this work, an ultra-violet (UV) photocatalysis method in the presence of H_2O_2tilizing nano-TiO_2 photocatalyst is presented for the digestion of total phosphorus (TP) in water. The UV digestion of 4 mg/L of sodium glycerophosphate solutions (by weight of P) were conducted at different digestion time and concentrations of H_2O_2. The H_2O_2 added to the water samples could increase the formation rate of strong oxidant hydroxyl radicals (·OH), but excess H_2O_2 will consume ·OH and reduce the conversation rate. The optimum concentration of H_2O_2 obtained in this work was 740mg/L. At the condition of 60min and 740 mg/L of H_2O_2, the conversion rate of sodium glycerophosphate reached about 90%, and the maximum value of rate constant *k* was 0.0306 min^{-1}. Compared with the traditional thermal oxidation method for TP digestion, this UV/ H_2O_2 hotocatalysis digestion method enables the digestion process work at normal pressure. Compared with the individual UV photocatalysis process, UV/ H_2O_2 digestion method decreases the digestion time from two hours to about an hour.

2P1-049 **ANALYSIS OF ELECTROMECHANICAL INTERFACE MODEL FOR LIQUID FLOATED MICRO-GYROSCOPE** **No.372**

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This paper presents an electromechancial interface model of liquid floated micro-gyroscope, which can analyze sensing capacitors and resistance of gyroscope. The impacts of them are analyzed and simulated with the simulation software of circuit. The analytic results indicate that the reasonable interface circuit can substantially remove the impacts of these parasitic capacitances, increase the signal noise ratio. To ensure the high resolution, the model of liquid floated micro-gyroscope with ANSOFT conducted. The results show the transfer characteristics of the sensor and nonlinear error of transfer characteristics.

2P1-050 **A METHOD OF STRUCTURAL TRIMMING TO REDUCE MODE COUPLING ERROR FOR MICRO-GYROSCOPES** **No.374**

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This paper presents a novel method of structural trimming to reduce the mode coupling error with the focus on micro-gyroscopes. A UV nanosecond laser was used to remove materials with determined size at certain point on the vibratory structure of the micro-gyroscope. The peak-peak voltage of the mode coupling error signal of the gyroscope prototype studied in this paper could be reduced from 3.52V to 0.082V. Furthermore, the zero-velocity output of the same gyroscope prototype was decreased from 244mV to 14mV after coarse trimming and fine trimming. Demonstrated theoretically and experimentally, this structural trimming by UV nanosecond laser is an effective way to reduce mode coupling error for improving the micro-gyroscope performance.

2P1-051 **RELIABILITY EVALUATION OF MICROMIRROR OF DOUBLE S-SHAPED UNIMORPH PIEZOELECTRIC ACTUATOR WITH PROBABILISTIC APPROACH** **No.376**

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This paper presents the long time reliability evaluation of a micromirror with double S-shaped unimorph piezoelectric (dSUP) actuator design using a probabilistic approach. The lifetime (number of cycles to failure) of the piezoelectric actuator, electrical strength, and electrical load are considered as the random variables; and their probability distributions are discussed. The interference model of electrical load and electrical strength is used to evaluate the reliability of dSUP actuators. By this approach, the relationship between the reliability and the lifetime of the dSUP actuator has been deduced.

2P1-052 **REPEATABILITY STUDY OF 2D MEMS MIRRORS BASED ON S-SHAPED Al/SiO2 BIMORPHS** **No.377**

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MEMS devices based on bimorphs are affected by several effects including creep, stress, and fracture in bimorph structures. In this paper, we present the reliability study of an Sshaped bimorph MEMS mirror. The following tests are performed: 100 million cycle scanning, vibration, and isothermal holding. Only 0.4% scan angle change was observed after experiencing a 6-axis, 20g vibration. A maximum 0.7% change was measured after the MEMS mirror gone through an isothermal holding for 10 hours at 150℃. After a 100 million cycles of scanning, the maximum drift was less than 0.01.

2P1-053 **MAGNETO-FEM ANALYSIS FOR MICRO ACTUATOR USING ARRAY OF MAGNETIC ELEMENTs** **No.386**

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This paper reports a magnetic actuator using interaction between micro magnetic elements. It was already reported that the present actuator can work

even if the structure was miniaturized to nano-scale. In the present work, simple fabrication process with photolithography and PDMS casting was employed to obtain beam type structures with micro array of magnetic elements on their surface. Two samples with simple grid patterns were prepared for testing. These samples had the same grid pattern but different orientation, which caused directly opposite bending deformation under the same applied magnetic field. We used magneto finite element method (FEM) to explain the behavior of the present actuators.

2P1-054 **CANTILEVER ARRAYED BLOOD PRESSURE SENSOR FOR ARTERIAL APPLANATION TONOMETRY ……No.409**

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We developed a cantilever-arrayed blood pressure sensor array fabricated by (111) silicon bulk-micromachining for the noninvasive and continuous measurement of blood pressure. The blood pressure sensor measures the blood pressure based on the change in resistance of the piezoresistor on a 5-μm-thick-arrayed perforated membrane and 20-μm-thick metal pads. The length and width of the unit membrane are 210 and 310 μm, respectively. The width of the insensible zone between adjacent units is only 10 μm. The resistance change over contact force was measured to verify the performance. The good linearity of the result confirmed that the PDMS package transfers the forces appropriately. The measured sensitivity was about 4.5%/N. The maximum measurement range and resolution of the fabricated blood pressure sensor were greater than 900 mmHg and less than 1 mmHg, respectively.

2P1-055 **A NOVEL FLEXIBLE CAPACITIVE MICROMACHINED ULTRASONIC TRANSDUCER (CMUT) ARRAY WITH ISOLATED METALLIC ISLANDS RIVETED TO A POLYMER FILM ……No.414**

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This paper reports a method for fabricating CMUT arrays using a novel rivet structure to fasten isolated metal islands to the flexible polymer film. Previously, a stretchable CMUT array was reported from our group, in which both the membrane and the cavity were fabricated using polydimethylsiloxane (PDMS) then bonded together by O_2 plasma when electrodes were made by screen-printing of liquid metal alloy. Comparing to the PDMS membrane, the nickel membrane used here has higher resonant frequency for ultrasonic imaging. In this CMUT array, nickel over-plating is employed to form the rivet structure for securing metal islands to the polymer film, which can solve the adhesion problem between metal and polymer. EPON 1002F photoresist can be patterned to form via holes and also serves as the polymer film.The calculation result shows that the concave bottom electrode can increase the device capacitance compared to the rectangular bottom. The preliminary experimental result shows a resonant frequency at around 6.25MHz by using an impedance analyzer.

2P1-056 **AN ELECTROSTATICALLY DRIVEN PERISTALTIC MICROPUMP WITH AN INDIUM TIN OXIDE ELECTRODE ……No.416**

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An electrostatically driven valveless double-sided peristaltic micropump with an indium tin oxide (ITO) transparent electrode has been developed for gas chromatography. In order to verify the motion of the pump, an ITO-ITO micropump was fabricated, and in order to measure flow rate, an ITO-Si micropump was fabricated. The micropump was fabricated on an ITO on glass substrate and a silicon substrate with a polyimide membrane. A maximum flow rate of 27.19 μl/min was measured at 4 Hz and 100 VDC. The micropump was operated by 4 electrodes with a 4-phase sequencing actuation.

2P1-057 **STRUCTURE DESIGN OF OUT-PLANE EVANESCENT COUPLING ACCELEROMETER WITH SUB-WAVELENGTH GRATINGS ……No.423**

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Evanescent Wave Coupling accelerometer, based on near-field evanescent waves coupling by means of sub-wavelength gratings, is a novel MOEMS accelerometer with high performance. It is widely used in highly precise navigation, seismic sensing and oil-field etc. for its immunity to electromagnetic interference, remote sensing, extremely high-sensitivity[1]. However, it is difficult to realize such kind of accelerometer due to the fabrication of sub-wavelength gratings with high aspect ratio. Recently, out-plane MOEMS accelerometer based on evanescent wave coupling using sub-wavelength gratings has generated considerable interest for its fabrication simplicity. We envisioned a novel out-plane evanescent wave coupling accelerometer with high precision integrating the large mass, weak spring and sub-wavelength gratings together. Design and simulation of the overall structure were made with ANSYS. The novel out-plane accelerometer was finally designed with displacement sensitivity 2023 nm/G, corresponding to 1st diffraction beam optical sensitivity 0.46%/mG. These results provide a theoretical basis for design and fabrication of out-plane evanescent coupling accelerometer.

2P1-058 **FABRICATION AND ANALYSIS OPTICAL MICROSPHERE CAVITY BASED ON HIGH Q ERBIUM-DOPED …No.427**

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Using CO_2 laser metal method process the top of erbium-doped tapered fiber, which formed by stretching a standard optical fiber (SMF-125) while heating it with a hydrogen flame. The top of tapered fiber formed erbium-doped microsphere cavity with higher spherical by its surface tension when heating is stopped. The size of erbium-doped microsphere is 21μm. The position of erbium-doped microsphere is accurately adjusted between the pump power and monochromatic spectrometer so that it can be easily excited by 980 nm and 1480 nm infrared light. Excited erbium ions produce energy level transition and a number of sharp transmission spectrums are observed around the center wavelength of 1550nm. It expanded the spectrum wide and proved the frequency selection role of micro-cavity. Further analysis of the experimental results, we obtained the quality factor $Q=4.4\times10^8$ through calculating the transmission spectrum which is consistent with the theoretical value largely.

2P1-059 **STRUCTURE DESIGN AND SIMULATION OF MICRO DYNAMICALLY TUNED GYROSCOPE WITH THREE EQUILIBRIUM RINGS ……No.430**

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The structure of a micro dynamically tuned gyroscope (MDTG) with three equilibrium rings has been designed to eliminate the error caused by the double rotation frequency of the driving shaft like traditional DTG. Some simulations under the optimized structure parameters are given. The mode frequency is separated from 167Hz of the rotation frequency of the motor as simulated. The static deformation is controlled within less than 1μm under gravity and a load in our mechanical simulations. The dynamic deformation is simulated when the rotor rotates at a specified speed. The assembly distance between the electrode plates and the rotor disk is chosen from 40μm to 60μm after the static capacitance simulation.

2P1-060 **TIP-TILT-PISTON PIEZOELECTRIC MICROMIRROR WITH FOLDED PZT UNIMORPH ACTUATORS ……No.431**

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This paper presents the design, fabrication and characterization of a novel tip-tilt-piston (TTP) scanning micromirror based on an array of folded piezoelectric unimorph actuators. The micromirror can perform rotational scan around two in-plane orthogonal axes as well as out-of-plane piston motion. The measured resonant frequencies of the fabricated micromirror are 362 Hz (piston), 685 Hz (x axis scan), 1250 Hz (y axis scan) and 19.2 kHz (fast y axis scan), respectively.

2P1-061 **ARTIFICIAL HAIR CELL SENSORS USING LIQUID METAL ALLOY AS PIEZORESISTORS ……No.434**

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In this paper, we present the design, fabrication process, and testing results of an artificial hair cell sensor made by liquid metal encapsulated in a polydimethylsiloxane (PDMS) substrate. Previously, a flexible force sensor was reported from our group, which can detect both normal and shear forces by using liquid metal alloy (Ga-In-Sn) as piezoresistive gauge material encapsulated in a PDMS substrate. Based on this method, we propose an artificial hair cell sensor which can detect two-axis tactile force with a standing artificial hair shaft. Since the liquid-metal piezoresistors deform with the elastomeric substrate, normal and shear force can be detected with resistance changes of the piezoresistors. Each force sensor comprises a pair of symmetric piezoresistors, which is screen-printed on a suspended PDMS membrane with opposite direction to be sensitive to shear forces. The testing results demonstrate the sensitivity of the force sensor in two-axis directions.

2P1-062 **A MICROMACHINED GYROSCOPE WITH AN EFFECTIVE STRESS-RELEASED FRAME ……No.441**

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Structural stress is one of the main factors that influence the performance of micromachined gyroscopes. This paper mainly analyzed the origin of heat stress and its impact. Then an elastic stress-released frame structure was designed to reduce the heat stress of the micromachined gyroscope. Simulations were done to prove the effect of the novel structure. Also, a dry-wet-etch-combined fabrication method was put forward to fabricate the micromachined gyroscope. Finally, the vacuum property of the gyroscope was tested as well as the scale factor and the bias stability. The scale factor was 50 mV/°/s and the zero bias stability turned out to be 58.60, 35.00 and 31.14 when it started 0 second, 10 minutes and 15 minutes after it was charged.

2P1-063 **A TRIAXIAL MONOLITHIC SILICON ACCELEROMETER WITH IMPROVED TEMPERATURE CHARACTERISTICS ……No.444**

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A novel triaxial monolithic silicon accelerometer with improved temperature characteristics is presented in this paper. Two methods were put forward to improve the temperature characteristics of the accelerometer. One is the optimization of the anchor configuration to decrease the temperature drift, and the other is the integration of an on-chip matching capacitor to counteract capacitance variation. A facile micromachined process flow was investigated, and the differential capacitance readout circuit was setup. The FEM simulations and experimental results prove that the methods are available and effective.

2P1-064 **MICRO-FABRICATED POLYMERIC THERMAL ACTUATORS ARRAY FOR RECTIFYING THE DEFORMATION OF MEMS SUBSTRATE ……No.456**

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To improve the performance of MEMS device, it is critical that the effect of environmental parameters on these devices be controlled or eliminated. In this paper, we first developed a novel technique by employing thermal actuator and actuators array to rectify the micro deformation of MEMS substrate due to thermal mechanical stress as a result of temperature variation. This PTAA consisting of a 50 μm thick silicon membrane which is supported by an actuators array. The polymeric thermal actuator array (PTAA) was fabricated utilizes SU-8-2100 (Microchem Crop., USA) as the main functional material and thin Titanium/Aluminum(Ti/Al) electrode layer as the microheater. The numerical analysis of the PTAA was implemented with ANSYS based on an thermal-mechanical coupled simulation. According to the analysis results, the actuators tend to have relatively high stiffness and large displacement in actuation direction, reaching 3μm in simulation. The PTAA were able to achieve accurate rectifying of the substrates' deformation. We mainly present the design, simulation and operation principle of this novel PTAA.

2P1-065 **CAPACITIVE MICROMACHINED ULTRASONIC TRANSDUCER AS A RESONANT TEMPERATURE SENSOR…… No.476**

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The capacitive ultrasonic transducer (CMUT) was initially proposed for temperature measurement. A simple CMUT structure and the corresponding matching circuits were designed. Then the effects of vibration modes and bias voltage on sensitivity were analyzed by the finite element method. The results showed that the resonant frequency varied almost linearly with the temperature over the range of 45 ℃ to 120 ℃, and the sensitivity and the nonlinear error were about -1931.6ppm/℃ (or -21.2 kHz /℃) and 1.33% respectively when the CMUT working at the first order vibration mode with a bias voltage of 22.05V. It was demonstrated that the first order vibration mode had a higher sensitivity than the other three higher modes and the sensitivity could be adjusted by the bias voltage.

2P1-066 **DIGITAL CLOSED-LOOP DRIVER DESIGN OF MICROMECHANICAL GYROSCOPES BASED ON COORDINATED ROTATION DIGITAL COMPUTER ALGORITHM ……No.499**

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A novel digital closed-loop driver is presented for a micromechanical vibratory gyroscope in this paper. Coordinated rotation digital computer algorithm is applied to generate the sine and cosine signals for driving and demodulation processing. Meanwhile, automatic gain control and phase-locked loop are adopted to maintain a constant velocity of the drive mode and guarantee the gyroscope working in the resonant mode. All the control methods are implemented in FPGA device. Experimental results demonstrate that the stability of the amplitude of the drive velocity is about 18ppm, which verifies the effectiveness and accuracy of the digital closed loop for the drive mode. The scale factor, nonlinearity and bias instability of the gyroscope with closed loop controlled sense mode are measured to be 18.5mV/deg/s, 0.088% and 19.4deg/h, respectively.

2P1-067 **AUTOMATIC DETECTION AND COUNTING OF NEMATODES USING A NEW PORTABLE LENSLESS IMAGING PLATFORM ……No.508**

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This paper demonstrates a low-cost portable hologram imaging platform combined with an automatic detection and counting algorithm of micro-object. The aim is to develop a system to automatically count nematode. The developed algorithm is composed of several steps. Hologram images captured from our platform are preprocessed to enhance the raw images and improve further analysis. The second step of the algorithm is based on feature extraction which is a necessary step to describe the detected data. The final step is the classification of the feature combination into two separates class, nematodes and non-nematodes elements, which is based on a kmean classifier. Numerous tests have been performed to select the best feature combination, yielding high detection and counting rate. The average computational time is of 52.37 seconds, specificity and sensitivity of our algorithm on a 2593×1944 pixels image are 0.978 and 0.923 respectively. The algorithm is only focused on the detection and counting problem and not on computational time.

2P1-068 **REALIZATION OF QUARTZ MEMS ACCELEROMETER BASED ON FLIP CHIP PROCESS ……No.514**

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This research attends to provide a simple and effective way to precisely assemble a quartz MEMS accelerometer, which is composed of a double-ended tuning fork (DETF) force transducer, and a base-proof mass structure. Flip chip method is proposed to bond the two sides of DETF in length direction onto the base and proof mass structure via AuSn solder utilizing the self alignment function of reflow process. Finite element analysis method is used to design and optimize the sensor structure including the dimensions of DETF, mass proof and solder bump height and so on. The optimized accelerometer sensitivity is about 50 Hz/g at a fixed planar dimension in 4 mm×8 mm. The DETF is fabricated on a 100 μm thick Z cut wafer and the monolithic base-proof mass structure, which is linked with a thinned flexure, is fabricated on a 300μm thick wafer using well established quartz MEMS wet etching process.

2P1-069 **WEAK LIGHT CHARACTERISTICS OF A NEW PHOTOELECTRIC SENSOR WITH POTENTIAL BIOSENSOR APPLICATION ……No.554**

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We have designed and developed a field deployable biosensor unit based on a novel proprietary quantum dots-quantum well hybrid structure. We analyzed in detail the detection sensitivity and in particular weak light detection and analysis of the semiconductor optoelectronic device. We designed a readout circuit and a data processing unit to handle the response signal. The sensor unit is equipped with a LCD element for data display and can be used in a centrally managed real-time monitoring system such as for infectious disease management and bio-aerosol monitoring. The high sensitivity of our sensor enables fast and reliable spectral results to aid rapid identification of biological samples.

2P1-070 **DESIGN OF A NOVEL DEVICE FOR LIVER CANCER BIOMARKERS DETECTION ……No.161**

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Cantilever-based sensors have been widely used in biochemical analysis [1]. However, for the cantilever sensor working in a dynamic mode, the resonance frequency shift not only depends on the mass change, the variation of lever stiffness k caused by the biomolecular adsorption also could have substantial contribution to the frequency shift, and this will result in distinct error for mass detection [2]. In this paper, a novel cantilever array sensor was micro-fabricated for precise bio-marker detection. In order to reducing the effect of k variation due to adsorption, a local biochemical reaction cavity was designed in the free end of the cantilever. Thus the adsorption of cancer biomarker takes place only in the local region of the cantilever instead of the whole lever. This configuration has dramatically improved the performance of the biosensor.

2P1-071 **A X-BAND SWITCHED-LINE 5-BIT PHASE SHIFTER WITH RF MEMS MULTITHROW SWITCHES ……No.189**

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In this paper, a 5-bit switched-line phase shifter is designed, processed and tested for X-band application, which is based on packaged RF MEMS single-pole double-throw(SPDT) and single-pole four-throw(SP4T) switches to get an compact structure. The design and optimization are carried out by analyzing the non-ideal performance of packaged RF MEMS switches and extracting their circuit model parameters. The effects of the bonding-wire connecting RF MEMS switches and peripheral circuits are also analyzed and modeled. The 5-bit phase shifter shows the average measured insertion loss of -3.1 dB, the average return loss of -21.1 dB, and the average absolute phase error of 2.2°at 10GHz. By comparison of simulations and measurements, this paper proposes that the main factors to effect the performances of phase shifters with packaged MEMS switches are parasitic inductances introduced by the bonding- wire and limited isolation of the used switches.

2P1-072 **ENERGY REVERSIBLE SI-BASED NEMS SWITCH FOR NONVOLATILE LOGIC SYSTEMS ……No.282**

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The paper presents design, analysis and fabrication of novel silicon-based, low power, non-volatile NEMS logic switches. Non-volatility is achieved by exploiting the Casimir effect and the van der Waals force at mechanical contact between an in-plane, laterally moveable transistor channel and two opposing side gates. Mechanical symmetry is implemented in the design for switching to be energy reversible. Device operation is simulated by coupling close range interatomic force calculations with 3D FEM simulation. 'On' and 'Off' transistor states are maintained by controlling the surface area of mechanical contact between the beam and the gate electrode. To achieve this, two nano-stiction state controller designs are proposed for experimental comparison. Preliminary devices have been successfully fabricated using ebeam lithography to verify minimum feature size of proposed structures.

2P1-073 **METAL-CATALYST FREE INTEGRATION OF SiO_2 NANOWIRES INTO CARBON MEMS ……No.350**

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We presents an innovative technique of integrating silica nanowires to photoresist-derived carbon microelectromechanical systems (C-MEMS) on silicon substrate. The silica nanowires were synthesized through thermal treatment in a tube furnace at 1200 ℃ under a gaseous environment of N2 and H2. The stiff morphology and radicalized distribution around carbon posts of nanowires was observed, which was different from previous studies. High-temperature annealing and meticulous-controlled pyrolying atmosphere could affect the formation of unusual SiO2/C-MEMS integrated structures.

2P1-074 **ALGORITHM ANALYSIS OF PHM FOR SENSITIVE CARGO TRANSPORTATION ……No.357**

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Several Prognostics and Health Management (PHM) algorithms are to be analyzed in this paper, and the purpose is set to master the know-how of the optimization of the prognostic algorithms. To implement the PHM for sensitive cargo transportation, based on the original data collected during the dedicated tests, applying the microsystem hardware designed and assembled by the research team, as well as the embedded software. At the end, the framework of the system platform in the future is layouted.

2P1-075 **HIGH IMPACT-INDUCED FAILURE OF A NOVEL SOLID MEMS SWITCH ……No.358**

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Due to the rapidly growing MEMS initiator market and the needs for smaller, safer and higher integration, more advanced switches are in demand. The novel solid MEMS switch can improve the security and reliability of MEMS initiator, while the leads of its package are weak under high impact. This paper mainly studied the leads reliability of the novel solid MEMS switch under high impact by FEM simulation analysis. Through simulation analysis, the mainly weakness and the potential failure modes of the leads under high impact can be obtained, which can provide theory reference for the design and application of the novel solid MEMS switch.

2P1-076 **A HIGH POWER SUPPLY REJECTION RADIO VOLTAGE REFERENCE FOR ENERGY HARVESTERS ……No.379**

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This paper presents a design of a high power supply rejection radio (PSRR) bandgap voltage reference (BGR) which is used in the processing circuit of energy harvesters. The improvement of the PSRR of the BGR is implemented through adding a pre-regulating circuit to improve the low frequency PSRR and a low pass filter to improve the high frequency PSRR. The BGR is verified by using SMIC 0.18um 1P6M process. The supply voltage is 2.5 V and the BGR provides a reference voltage of 1.19 V. The simulation results show that the PSRR at 1MHz is about -40 dB and the PSRR at DC region is about -125 dB. This circuit also enhances the line regulation performance. A stable output voltage can be obtained when the supply voltage varies from 2.5 V to 6 V. The overall current consumption of this design is less than 50μA.

2P1-077 **RESEARCH ON OPTICAL BIOLOGICAL SENSOR USED AS QUANTITATIVE ANALYSIS OF GLUCOSE ……No.425**

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In this paper, we designed and fabricated the biological sensor structure on silicon-based chip and then fixed glucose oxidase molecular on the silicon wafer in chemical bond forms through surface oxidation activation, silane coupling agent deposition, link molecules fixing and glucose oxidase linking. Micro-ring resonator with whispering gallery mode is developed to improve the Q factor and thus enhance the sensitivity of the bio-sensor. In this way, quantitative analysis of the glucose in the test liquid can be achieved through the biological sensor by measuring the shift of the resonant wavelength in transmission spectrum.

2P1-078 **TWO STEPS CONTROLLED RELEASED MICRONEEDLE PATCH USED FOR HYPERPIGMENTATION ……No.437**

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Transdermal delivery is an efficiency way to deliver active ingredients without degraded by GI system and EPR effect. In these years, microneedles patch fabricated by micro mechanical approach allows us to across the skin feasible for a much wider rang of drug. For the traditional treatment of hyperpigmentation, a fixed triple combination cream offer maximal efficacy for clinical trial. However, clinical study showed that over 87.5% of patients were noted to have side effects with cream treatment. Here we propose a new design of microneedles patch with better drug localization in different skin layer to treat hyperpigmentation and two- steps controlled released microneedle to eliminate the irritation. The two-step release microneedle patch made of two kinds of biomaterial is prepared by controlling the concentration of tip material. This approach can be a potential technology enabling direct transcutaneous delivery in clinical applications.

2P1-079 **EFFECT OF IN ADDITION ON MECHANICAL PROPERTIES OF Sn-9Zn-In/Cu SOLDER ……No.454**

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In this study, trace amounts (0.5-2 wt%) of indium (In) are added to the Pb-free Sn-9Zn solder. Expect to improve the mechanical properties and find out the optimum conditions of Sn-9Zn-In solder. Tests are conducted to measure micro-hardness and shear strength while microstructure and morphology of fracture surface are observed using scanning electron microscope with elemental composition analyzed by energy dispersive spectrometer. Results show that addition of In to Sn-9Zn solder alloy leads to needle-shaped precipitates formed in the substrate. This not only increases micro-hardness, but also enhances shear strength at Sn-9Zn-In/Cu solder joints. Improvements in both micro-hardness and shear strength confirm that adding In to the solder alloy can contribute to better mechanical properties of Sn-9Zn-In/Cu joints with proper control of soldering temperature and time.

2P1-080 **FAST SYNTHESIS OF DENDRITE CRYSTALS ASSISTED BY ACEO AND THE CONTROLLABLE SURFACE-ENHANCED RAMAN SCATTERING IN ELECTRIC FIELD ……No.457**

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A simple and cost-effective orient electrodeposition strategy was developed to synthesize Au dendrites. Dendrites morphology can be prepared by adjusting the parameters, including electrolyte concentration, electrodes shape, AC voltage and frequency. These Au dendrites exhibited well

reproducible surface – en-hanced Raman scattering (SERS) effect using Rhodamine B (RhB) as model molecule. Further experimental results demonstrated that surface enhancement ability can be tuned by external DC electric filed. Our work not only provides a very simple, convenient, cost-effective, and fast route to synthesize Au dendrites, but also opens up new thinking on intelligent platform of new in-situ SERS sensing instruments.

2P1-081 **INTEGRATING THE MICRO-HEATER AND MICROFLUIDIC CHIP TO GENERATE THE GELATIN EMULSIONS AND MICROCAPSULES ……No.553**

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The heatable microfluidic chip successfully integrated the micro-heater and flow-focusing device to generate the gelatin emulsions under the various flow rate ratios and voltage, and the gelatin emulsions can apply to encapsulate the vitamin C for drug release. Our purpose is to create the heatable condition for thermo-sensitive hydrogel material and generate the uniform emulsions under any external environment. The gelatin emulsion size is ranged from 45 μm to 120 μm in diameter. Moreover, the gelatin microcapsules of various sizes with the vitamin C was used for drug release.

2P1-082 **CONTROL OF SWIMMING IN CRUCIAN CARP: STIMULATION OF THE BRAIN USING AN IMPLANTABLEWIRE ELECTRODE ……No.208**

Chuan Zhang, Jingquan Liu, Hongchang Tian, Xiaoyang Kang, Yuefeng Rui, Bin Yang, Hongying Zhu, Chunsheng Yang
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Control of locomotion in different kinds of animals, or so-called bio-robot, has been reported. Bio-robot is a technology based on the information communication between the nerve tissue and the computer. In this work, to study the locomotion control in carp's brain, a Parylene-based wire microelectrode is fabricated for stimulation in midbrain. Compared with traditional microelectrodes, wire electrodes provide better bio-compatibility and good mechanical stability. The whole electrode was covered by Parylene C film, except the stimulation sites which are exposed by lift-off process, thus the interface impedance is significantly reduced. After the fabrication, crucian carps was anesthetized in MS-222 water solution and the cranium was partially removed to expose the midbrain. After all these steps, electrodes are tested to see if they are properly insulated. Then one electrode is implanted into the crucian carp's midbrain by surgical procedure and the movement of the fish is observed by a video camera. The caudal fin movement of crucain carp is successfully induced by applying a single polar pulse train. This result proved the former theory that control region of carp is located in midbrain. On the other hand, the experiment shows great potential and promising future in the bio-robotic fish.

2P1-083 **SELECTIVE DISPERSION OF HIGH PURITY SEMICONDUCTING SINGLE-WALLED CARBON NANOTUBES WITH POLYMERS FOR PRINTED THIN FILM TRANSISTORS ……No.224**

Long Qian[1, 2], Jianwen Zhao[1]
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Single-walled Nanotubes (SWCNTs) have been regarded as one of most promising materials for fabricating high-performance thin-film transistors (TFTs). However, it is difficult to obtain the high-performance SWCNT TFTs due to the presence of metallic SWCNTs. With the aid of appropriate polymers (regioregular poly(3-dodecylthiophene, rr-P3DDT), solvent and temperature, we can achieve highly selective dispersion of semiconducting-SWCNTs (s-SWCNTs) and the high-performance SCNT TFTs with on/off ratio up to 2×10^7 and mobility up to 1.2 cm2 $V^{-1}s^{-1}$ were obtained. It opens a way to print high-performance SWCNT TFTs based on the sorted s-SWCNTs.

2P1-084 **LOW TEMPERATURE SYNTHESIS OF CUBIC $BaTiO_3$ NANOPARTICLES ……No.227**

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A new process has been developed to prepare nanocrystalline $BaTiO_3$ at room temperature and atmospheric pressure. The experimental results show that cubic $BaTiO_3$ nanoparticles can be prepared even at room temperature (25℃). These cubic $BaTiO_3$ nanoparticles are irregular quasi-spheres with the size rangining from hundreds of nanometers to tens of nanometers as the temperature is increased from 25 to 80℃. Raman spectra of the products obtained at different temperature confirmed that the $BaTiO_3$ were cubic phase. The influence of reactants concentration on the formation of $BaTiO_3$ nanoparticles was also investigated.

2P1-085 **TUNNELING EFFECT ON ENHANCED OLED PERFORMANCE USING Al_2O_3 BUFFER LAYER ……No.230**

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It has been found that introduction of buffer layers between organic holes transport layer and anode layer plays an important role in improving device stability and hole injection efficiency of organic light-emitting diodes (OLED). As for the mechanism of the improvement due to the buffer layer, it is still controversial. To understand the mechanism behind the enhanced performance of OLED by the buffer layer, a new model is therefore proposed which combines classical model and quantum tunneling model to explain the OLED performance improvement. A thin Al_2O_3 insulating buffer layer deposited on indium tin oxide (ITO) anode by atomic layer deposition has been investigated for OLED. The observed power efficiency and current efficiency improvement at the optimal thickness of 1.4 nm are well explained by the model. A series of Al_2O_3 ilms of different thicknesses were deposited on ITO anode and characterized. Their roughness, sheet resistance, surface potential, and resulted OLED current density were investigated. It is believed that the blocking of hole inject by the Al_2O_3 buffer layer makes more balanced carrier density in emission layer, thus enhances the current

efficiency. Though less number of holes are injected in OLED due to the insertion of Al_2O_3 layer, quantum tunneling through the ultra-thin buffer layer play an important role to contribute to the hole injection, which avoids crossing the interface barrier, resulting in less energy consumed and power efficiency enhanced.

2P1-086 **HIGH PERFORMANCE THIN-FILM TRANSISTORS USING POLYMER/SWCNT COMPOSITE SEMICONDUCTING INK ……No.233**

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A novel conjugated polymers have been used for selectively dispersion of high purity semiconducting SWCNTs for the application in high-performance thin-film transistors (TFTs). With the sorted s-SWCNTs, we achieved high-performance SWCNT transistors with very high charge-carrier mobility and on/off current ratio synchronously.

2P1-087 **PRINTED CATHODE WITH ALUMINUM INK FOR FLEXIBLE ORGANIC ELECTRONIC DEVICES ……No.237**

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An Al precursor ink, OAlH3 (C2H5)2 has been prepared which can easily decompose and form metal Al at normal pressure and low temperature (80 ℃) with the catalyst of TiCl4. The prepared Al films by drop-casting show a good quality with low resistance (1.86 Ω·cm) and low work function (3.76eV). Cathodes prepared with the Al ink for flexible organic electronic devices on PET are also investigated by aerosol jet printing process, which indicates that printed Al cathode is a promising method to fully printable flexible devices such as organic light-emitting diodes, organic photovoltaic.

2P1-088 **HIGHLY CONDUCTIVE NANOSILVER INK TREATED AT MILD TEMPERATURES BY REDUCING THE AMOUNT OF PVP ……No.306**

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Silver nanoparticles colloid was obtained by reducing the high molar concentration of $AgNO_3$ (up to 3.92 M) with the hydrazine hydrate ($H_4N_2 \cdot H_2O$) as reductant in the presence of polyethylene pyrrole (PVP) as the protectant. It was well known that the polymer protective agent capped on the surface of silver nanoparticles could control the particles growth and stabilize the nanosilver suspension. Meanwhile, the insulative PVP capped on the surface of nanosilver could prevent the transfer of electrons, resulting in the conductivity decreasing of the corresponding nanosilver films. Thus, the amount of PVP should be reduced in order to improve its conductivity. The silver nanoparticles was treated by the chemical sedimentation, which is the most widely used solid-liquid separation method in the preparation of nanosilver conductive printing ink, for its low costing and without destroying the structure of the silver nanoparticles. It was found that the treatment can effectively reduce the amount of PVP. Good dispersion and electrical conductivity nanosilver ink can be obtained by acetone sedimentation for three times. The average size of the particles after sedimentation is 120.3nm, while the initial size is 92nm and no precipitation was observed even after aging for 15 days. Surface resistance of the silver layer coated on PET can be reduced to 226.4mΩ/□ after heating at 100oC for 30s, and the conductive ink with these properties can be widely used in preparation of transparent conductive film and RFID antennas.

2P1-089 **FABRICATION OF HIGHLY TRANSPARENT ULTRATHIN FILMS BASED ON REDUCED GRAPHENE OXIDE ……No.333**

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We developed a facile and reproducible method for fabrication of reduced graphene oxide (rGO) ultrathin films with high transparency (over 85% at 550 nm), uniform sheet resistances (~106 Ω/sq), and controlled thickness. The rGO ultrathin films can be successfully obtained when spray-coated rGO on glass slide was immersed in deionized water, and can be easily transferred to any substrates of interesting for further construction of optoelectronic-devices.

2P1-090 **SYNTHESIS AND SIZE CONTROL OF NANO/SUBMICRON COPPER PARTICLES BY FEEDING STRATEGIES ……No.342**

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Using Copper nitrate trihydrate ($Cu(NO_3)_2 \cdot 3H_2O$) as precursor, hydrazine hydrate ($N_2H_4 \cdot H_2O$) as reducing agent and Ploy(N-vinylpyrrolidone) (PVP) as capping agent in the presence of Diethylene glycol (DEG), highly monodisperse copper particles with different diameters were successfully synthesized via polyol method by different feeding strategies. Dynamic light scattering (DLS) and Scanning Electron Microscope (SEM) were used to characterize the morphology and particle size of these particles. X-ray diffraction (XRD) was used to measure the chemical constituents of these particles. UV-Vis spectrophotometer was used to signify the absorption spectrum of these particles. The results indicated that copper particles with controllable diameter can be synthesized by different injection rates. The average sizes of the prepared copper particles under 2, 4, 6, 8 ml/min of injection rate were 100nm, 200nm, 300nm, 400nm. The obtained copper particles were phase-pure crystalline, and their structure was face-centered cubic (fcc).

2P1-091 **SYNTHESIS OF NANO-COPPER PARTICLES FOR CONDUCTIVE INK IN GRAVURE PRINTING ……No.364**

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Controllable and mono-disperse copper anoparticles were synthesized via a simple chemical method which copper nitrate trihydrate, hydrazine hydrate and poly (vinylpyrrolidone) were used as copper source, reducing agent and capping agent, respectively. Copper nanoparticles so-prepared were characterized by UV-Visible spectroscopy, X-ray diffraction measurements (XRD), scanning electron microscopy (SEM). The colloid of the copper nanoparticles was obtained after washing and centrifuging by deionized water and acetone three times by which impurity ions can be removed. Suspension of nano-copper conductive ink for gravure printing was obtained by adding some solvent and additives. Then, samples were obtained by proofing and sintered under the nitrogen ambience. The resistance and thickness were measured. The result illustrated that the copper particles prepared have size about 80 nm and majority particles are spheroidal. The suspension of nano-copper conductive ink has 35.15% copper content according to thermal gravimetric analysis (TGA) and 1.29 % PVP. Surface resistance of samples proofing on polyimide film after sintering can reach 6.16 Ω/sq and the resistivity is $1.09\times10^{-4}\Omega\cdot$cm.

2P1-092 **WIRELESS ENERGY TRANSFER SYSTEM BASED ON HIGH Q FLEXIBLE PLANAR-LITZ MEMS COILS ……No.383**

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Wireless energy transfer system tends to replace the battery for the power supply of implantable prosthetic devices. Coils are the key point of the wireless transfer system and affect the transfer efficiency. In this paper, high Q flexible planar-Litz coil is designed and implemented for the wireless energy transfer system. Theoretical model of planar-Litz coil is given and the measurement result matches the theoretical analysis. The efficiency of wireless transfer system is improved by using the high Q planar-Litz coils. The experiment results show the coupling efficiency can be improved by about 40% as the transfer distance is 0.5cm. At last, resonant coils are added into transfer system to enhance the magnetic resonance, which makes the energy transfer efficiency improved greatly.

2P1-093 **GRAVURE FABRICATION AND STABILITY STUDY OF RFID ANTENNA ……No.395**

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In the article, low cost, RFID antenna is fabricated by gravure printing with PET acting as the substrate. The nano-silver ink with 50% silver content is prepared in the lab and the printing speed is set to 5m/min. After sintering at 150℃ for 2min, surface resistance of the antenna reaches to 7.31Ω/sq and thickness of the silver layer is 466nm. Then, the antenna is treated at -40℃ for 6h. Interestingly, the resistance of the antenna dropped by 9%, which may due to the limited motivation of PVP chain in relatively low temperature. In order to study its stability, the RFID antenna has been put into the night side, sunny side and room temperature for 30 days. The resistance is nearly the same as its original after 1 month, though some decreasing appeared. The result indicates that the antenna fabricated shows excellent stability and the working temperature can range from -40℃ to 150℃.

2P1-094 **PATTERNING OF ORGANIC THIN-FILM TRANSISTORS BASED ON BLEND SOLUTION VIA SELECTIVE DEWETTING USING KNIFE COATING ……No.400**

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Organic thin-film transistors array was prepared by selectively dewetting a blend solution of 6,13-Bis(triisopropylsilylethynyl) pentacene (TIPS_Pentacene) and polymer(methyl methacrylate) (PMMA) using knife coating. The blend films remaining in hydrophilic areas formed a TIPS_Pentacene-top and PMMA-bottom bilayer structure. This structure is beneficial for reducing the hysteresis effect and improving the electronic properties of OTFT devices because the PMMA bottom layer can act as a modifier to isolate carrier traps on the hydrophilic areas. Knife coating in wetting/dewetting process is a method to prepare uniformity performance devices in OTFTs array. The maximum mobility of this process is 0.062 $cm2V^{-1}s^{-1}$and average hysteresis effect (the D-value of two threshold voltages in dual sweep) is 2.3 V.

2P1-095 **EFFECT OF SELF-ASSEMBLED MONOLAYER(SAM) ON INKJET PRINTED ORGANIC THIN FILM TRANSISTORS OF POLYTHIOPHENE ……No.403**

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Organic thin film transistors (OTFTs) with bottom gate and bottom contact structure had been prepared by inkjet printing. It's found that the surface properties of the substrate have a great influence on the morphology of the droplet and the performance of devices. When a bare SiO2 layer was applied, the size of the dried droplet is about 60 μm and it's hard to form a uniform film. The best field-effect mobility of inkjet printed OTFT devices was only 6×10^{-4} $cm^2 V^{-1} s^{-1}$with an on/off current ratio of 60. After treating the substrate using a self-assembled monolayer (SAM) of trichloro(phenethyl)silane (PETS), the size of the dried droplet increased to 85 μm and a uniform the film was obtained. The best field-effect mobility of the obtained devices was up to 7.68×10^{-3} $cm^2 V^{-1} s^{-1}$with an on/off current ratio exceeding 103.

2P1-096 **INKJET PRINTING NARROW FINE AG LINES ON SURFACE MODIFIED POLYMERIC FILMS ……No.506**

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In the paper, we have demonstrated a simple but effective method to inkjet print fine Ag conductive lines with improved resolution on polymeric films. This is achieved by forming an ultra-flat polymeric film and modifying its surface energy. As a result, narrow Ag lines (< 50 μm) and short gaps (~10 μm) were successfully achieved using optimized printing parameters. Meanwhile these formed Ag lines show fine morphology, smooth surface and high electrical conductivity. The improved resolution is attributed to the reduced spreading of ink droplets on the surface modified substrate. This method shows the potential of directly producing high-resolution electrodes for printed electronics applications.

2P1-097 **TRANSPARENT ELASTIC CAPACITIVE PRESSURE SENSORS BASED ON SILVER NANOWIRE ELECTRODES ……No.509**

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Stretchable conductive films were produced by embedding silver nanowires onto the surface of biocompatible polydimethylsiloxane (PDMS) elastomeric membranes with low cost solution based processes. The films showed low sheet resistance (<12Ω/□) and good transparency (40% at 550nm). By laminating two films together, transparent elastic capacitive pressure sensors were made, which present higher sensitivity to that using Al foil as the electrode. A higher concentration of silver nanowire solution was also shown to be able to improve the sensitivity.

2P1-098 **ENHANCING FLUORESCENT RESPONSE OF IMMUNOSENSING BY A DEP CHIP WITH TRANSPARENT ELECTRODES AND MICROCAVITIES ARRAY ……No.249**

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Dielectrophoresis (DEP) has been demonstrated the manipulations of bio-modified particles for biosensors, and the microelectrodes are mostly made of metal materials such as Au, Cu and Pt, etc. However, the metal electrodes could induce extra background noise as observed the DEP chip in a fluorescence microscope. Currently, the fluorescence response still dominates the indicators of immunoassays; therefore, it's important to eliminate the extra background noise of fluorescence response form metal electrodes for an immunosensor. In this study, a DEP chip was utilized to immobilize the nanoprobes in a microcavities array for immunosensing. A transparent conductive material, Indium Tin Oxide (ITO), was employed in the fabrication of DEP electrodes, and the fluorescence responses of DEP chip with transparent (ITO) electrodes were compared with identical DEP chip with conventional Au electrodes during immunoassay. According to experimental results, the enhancement of fluorescence response of DEP chip with ITO electrodes was greater than the values of DEP chip with Au electrodes about 1.57 times and 1.44 times for the immunosensing of 10 nM and 1 nM BSA, respectively. In addition, by applying the DEP force during the immunosensing, the fluorescence response was also enhanced due to the BSA can be condensed by DEP force. The DEP condensation was more significant for immunosensing at low BSA concentration. Consequently, we have demonstrated a DEP chip with transparent ITO electrodes and the background noise of fluorescence response can be eliminated to enhance the sensitivity of immunosensing.

2P1-099 **A NANOMETER-RESOLUTION DISPLACEMENT MEASUREMENT SYSTEM BASED ON LASER FEEDBACK INTERFEROMETRY ……No.606**

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Based on laser feedback interferometry (LFI) combined with phase-freezing technology (PFT), a novel displacement measurement system is demonstrated, which improves the measurement resolution to nanometer scale. The phase modulator is added to modulate the external cavity phase, and the PFT is used for sampling and demodulation. The displacement information of the external target is reconstructed. The signal modulation, sampling, reconstruction technology is researched and the simulation results show the feasibility of the method. Error analysis is made for searching the influence of modulation frequency, sampling frequency and reflector vibration frequency. Verification experiment is made to check the accuracy of the system with appropriate parameters. It provides a displacement and vibration measurement method for MEMS elements.

2P1-100 **EFFECT OF THE CHEMISORBED MOLECULAR STRUCTURE ON THE FREQUENCY OF CARBON NANOTUBE RESONATORS: MOLECULAR DYNAMICS SIMULATIONS ……No.607**

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Tiny mass attached to the surface of carbon nanotubes (CNTs) would induce its intrinsic frequency shift. Due to their remarkable mechanical properties, such as exceptional high elastic modulus and low weight, CNTs hold significant potential as functional materials for the development of mass sensors and biosensors with atomic mass resolution. The effect of the structure of molecule covalently bonded to the surface of CNTs on its intrinsic frequency shift was investigated with fullatom molecular dynamics simulation (FAMDs), which explored the REBO potential and Lennard-Jones potential to represent the interatomic interaction. CNTs were constrained by the clampedclamped boundary condition and the fixed-free boundary condition, respectively. In order to highlight the effect of molecular structure on the fundamental frequency of CNTs, the simulated results via the FAMDs were

compared with those of additional mass molecular dynamics simulation (AMMDs), in which the mass of the attached molecule is lumped to the bonded carbon atom of CNTs. Results indicate that the structure of the covalently bonded molecular is strong enough to take effect on the frequency response of the CNT resonator.

2P1-101 **A NOVEL MICRO HEAT PIPE FOR HIGH-POWER LIGHTEMITTING DIODE MODULE ……No.608**

Yi Luo, Gang Liu, Liangliang Zou, Xiaodong Wang
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Light-emitting diode (LED) is a novel electronic light source that provides a direct transfer of electrical energy into light. A typical LED power package has a heat flux of 100W/cm^2, thus high power LEDs face severe thermal challenges due to their small size and general lack of a proper thermal path. The advantage of micro heat pipes (MHPs) is based on the phase change. With the trends of using silicon wafer as the substrate in LED manufacturing, a silicon-Pyrex MHPs was fabricated for quick spread of the heat from LEDs in this paper. Flat plate grooved MHPs is introduced. The grooves were fabricated on the silicon wafer and bonded to Pyrex 7740. Water as selected as the working liquid and the charge rate is 40%. The temperature test experiments were carried out to test the feasibility of the MHPs in LED heat conduction, and the preliminary experiment results indicate that the heat conductivity of MHPs is better than silicon wafer.

2P1-102 **FABRICATION OF STABLE SILVER NANOPARTICLES THROUGH A GREEN APPROACH ……No.609**

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we had suggested a novel method for the synthesis of silver nanoparticles by suitable choice of materials and solvents. It was a green, straight forward method in an aqueous medium. Additionally, nontoxic reagents were used in the experiment and the process was environmentally friendly. This green approach needs three reagents (dextran, tollens' reagent, glucose) which come from renewable resources. The effects of the concentration of tollens' reagent on silver nanoparticles formation and storage stability were studied. The silver nanoparticles were characterized by transmission electron microscopy (TEM), energy-dispersive X-ray spectroscopy (EDS) and UV-vis spectroscopy. The results indicated that the reaction parameters significantly affected the size, formation rate and distribution of the silver nanoparticles. This method is simple and economical therefore may be practical for large-scale synthesis.

2P1-103 **A COMPLETE ANALYTICAL MODEL FOR SQUARE DIAPHRAGM CAPACITIVE SENSOR WITH CLAMPED EDGES ……No.610**

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Capacitive Pressure Sensors have been among the most promising MEMS in recent years due to its inherently low power consumption, higher reliability and better performance. A complete analytical model is necessary to accurately determine the effects of sensing variables on the sensor. In this paper, a mathematical model is developed for square diaphragm capacitive sensors, which includes analytical equations for loaddeflection characteristic, pull-in voltage and critical distance at pull-in and capacitance. The work is different from the previous ones in the way that it adopts a direct method to solve the governing equations of deflection which gives the load-deflection characteristic without involving any numerical aid and accounts for both small and large deflection. Again, the numerical integration for capacitance calculation has been replaced by an approximate analytical model which reduces the computational effort comparably. Comparison with experimental data reveals excellent accuracy of the model.

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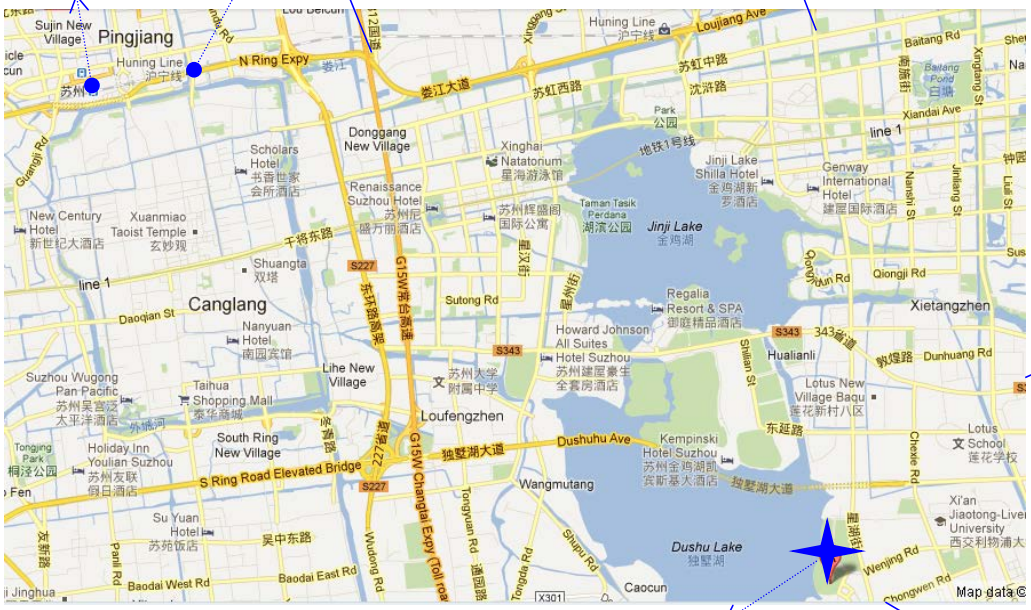

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Go To Suzhou

International Airport: Suzhou does not have its own international airport at present. It is best to use the airports of nearby Shanghai. Shanghai Hongqiao International Airport (SHA) and Pudong International Airport (PVG) are used frequently by domestic and international visitors.

- **Hongqiao Airport (SHA)**, is 86 kilometers (about 53 miles) away from Suzhou. Upon arrival, passengers could walk to the connected Shanghai Hongqiao Railway Station, and then take a bullet train to get to Suzhou in 30 minutes. Then please follow the guide of 'how to reach Worldhotel Grand from Suzhou railway stations.'

- **Pudong International Airport (PVG)**, is located 120 kilometers (about 65 miles) away from Suzhou. There are scheduled airport shuttle buses running to Suzhou, and vice versa. Please follow the sign "Long Distance Bus" to the bus station, where you can find the shuttle bus parking lots, at the 2nd floor of PVG's terminal building. Operating Time: 10:00 10:40 11:10 11:40 12:10 12:40 13:10 13:50 14:20 14:50 15:20 16:10 16:50 17:20 18:10 18:50 20:00. Durations: 3 hours; Ticket Fare: RMB 84.

When you arrive in Suzhou, please inform the driver you would like to get off at 'SIP'. (The other get off position is in downtown Suzhou, which would be farther from the conference venue). After get-off you can take a taxi to go to Worldhotel Grand. It will take about 20min and RMB 45.

In Suzhou: The Way from Railway Station to Conference Venue

1) From Suzhou Train Station:

- Taxi about 30 minutes, RMB 60.
- Bus:'Fast Line No.2 Bus', Get Off At' Dushulake Library';Change No.'156' or '176' Bus,Get Off At 'Dushulake Gymnasium', then walk about 500m to arrive at the hotel about 1 hour's drive.

2) **From Suzhou industrial Park Train Station:**

- Taxi about 15 minutes, RMB 35.
- Bus:No.'115', Get off at'Olive Bay', Change No.'156'或'176'Bus, Get Off at 'Dushulake Gymnasium', then walk about 500m to arrive at the hotel about 1 hour's drive.

3) From Suzhou North Station: Taxi abou 50 minutes, RMB 100.

Hotel Information

http://www.ieee-nems2013.org/hot.html (Online Booking and Information)

Note: Notice to attend IEEE_NEMS 2013, Send the email within valid date.

Hotel Name	Information	Distance
Worldhotel Grand Dushulake Suzhou **(ConferenceVenue)** （Add:No.299 Qiyue Street industrial Park）(the North of Dushulake Yueliangwan) ★★★★★	Tel: +86 512 69568888 -71326/71321 Email:reservations@worldhotelgranddushulake.com PS: Foreign Guest please scan two sides of credit card in Email.	0km
Four Points By Sheraton Suzhou (Add:No.8Dushulake Yueliangwan Road industrial Park)(Near Dushulake) ★★★★★	Tel: +86 512 6799 7999 Email: reservation.suzhou@fourpoints.com	0.5km
Jinling Guanyuan International Hotel Suzhou (Add:No.168 Cuiwei Street industrial Park Suzhou) ★★★★★	Tel: +86 512 62608888 Email: sales2_jinlingsz@vip.sina.com	1.0km
Home Inn (Suzhou Park Nanometer biological area) (Add:No.218 Xinghu Street)	Tel: +86 512 6281 1999/9	1.7km
Floft Hotel Suzhou (Add:3rd Floor1-A Area Creative Industry Park No.328 XinghuStreet industrial Park）★★★	Tel: +86 512-62925300 Email: huisuo@sistm.com.cn	1.8km
Jingzhai Hotel Suzhou (Add:No 158 Ren'ai Road industrial Park) ★★★★	http://www.jingzhaihotel.com/ Tel: +86 512 62601999-8855 Email: 15151414195@139.com	2.5km
Xi'an Jiaotong Liverpool International Conference Center (Add No.99 Ren'ai Road industrial Park Suzhou) ★★★★	Tel: +86 0512 8666 5555 Email: hongweiita@hotmail.com	3.1km

Travel Information

1) The Tiger Hill

Lying to west of the ancient city of Suzhou with a history of over 2,500 years, the Tiger Hill has the reputation of being No.1 sight of Wu region. “It would be a loss if you miss the Tiger Hill in your visit to Suzhou”(Su Dongpo).

2) Suzhou Museum

Founded in 1960 and originally located in the national historic landmark,Zhong Wang Fu palace complex, Suzhou Museum has been a highly-regarded regional museum with a number of significant Chinese cultural relics.

3) Ligongdi

Technical Tour

Nanopolis Suzhou

The Nanotech Commercialization Hub in China Suzhou has been designated by the Ministry of Science and Technology (MOST) as the 'China International Nanotech Innovation Cluster (CHInano)'. SIP launched the 'Nanopolis Suzhou' initiative to provide a complete ecosystem support for the growth of nanotechnology and its enabling industries. The industry areas of focus include micro and nano-manufacturing technologies, energy and green technologies and nano medicine. Suzhou intends to attract over 200 nanotech companies from all over the world and 10,000 nanotech experts within the next 5 years to make Suzhou the most global and innovative nanotech hub in China by 2015.

SINANO, CAS

Suzhou Institute of Nano-Tech and Nano-Bionics (SINANO) is a joint venture between Chinese Academy of Sciences and Jiangsu local government, with emphasis on applied research to help local industry and boosting local economy. It has 7 research divisions focusing on nanomaterials and devices, nanobiotechnology, printable electronics as well as other interdisciplinary fields. In addition, there are two facilities specialized for micro/nanofabrication and characterization/metrology with over $15 millions of equipments, which are fully open to outside users. SINANO also established wide international collaborations with research groups from US, Germany, Russia, Canada, Japan, Finland, Singapore, Hong Kong and many others regions or countries.

SVG Optronics

As the pioneer in the advanced micro/nano manufacturing, including UV laser maskless lithography, nano-patterning systems and roll-to-roll nano-imprinting technologies, SVG Optronics has established the capabilities in the functional micro-nano devices and optical films, such as ultra-thin light guide plates, large size touch panel sensors, 3D imaging, microlens array films and no-ink nano-printing, as well as the nano-light trapping and plasmonic technologies for improving LED's efficiency. SVG Optronics is a stock company in Shenzhen Stock Exchange, code: SZ300331, on June.28, 2012.

Contact Information

Conference Secretary

E-mail : IEEENEMS2013@Gmail.com

Phone & FAX: +86-10-62767742

Postal Address: IEEE-NEMS 2013 Conference

Address: Micro&Nanoelectronics Building .Room 319

Department of Microelectronics, Peking University

Haidian District，Beijing，China，100871

Conference Venue

All sessions will be held at Dushu Lake Hotel

Address: No.299 Qiyue Street, Suzhou Industrial Park (the North of Dushulake Yueliangwan)

Suzhou, China

Tel: +86 512 69568888 -71326/71321

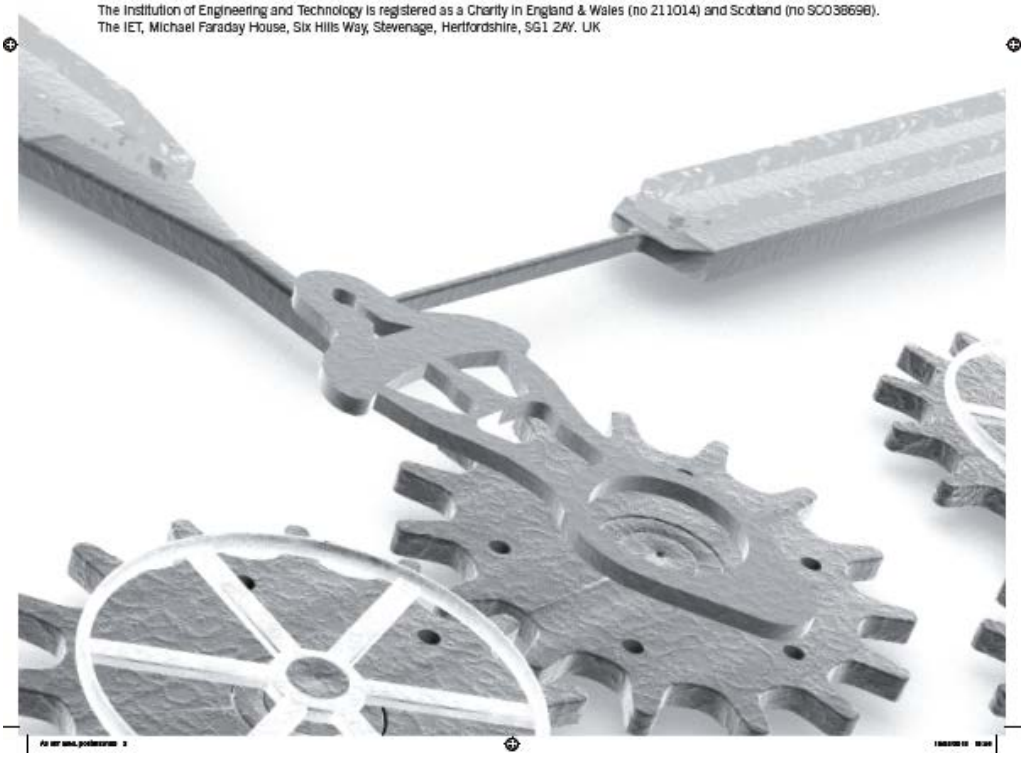
Electricity

The electric current used in China is 220V 50Hz. The hotels can provide 220V power outlets. Please note that plug adapters may be necessary.

Dialing Codes

China International Country Code: +86

Suzhou's Local Area Code: 512



IEEE-NEMS 2014

The 9th Annual IEEE Int. Conf. on Nano/Micro Engineered and Molecular Systems

Important Dates

- **September 15, 2013:** Paper submission[1] (2-6 pages)
- **October 31, 2013:** Notification of acceptance
- **December 15, 2013:** Submission of final full paper [2]
- **December 31, 2013:** Early bird registration deadline

1. To qualify for best paper contests, a submission must be from 4 to 6 pages

2. To be included in IEEE Xplore database, a paper must be from 4 to 6 pages

Waikiki Beach

General Chair: Wen J. Li, City University of Hong Kong, Hong Kong

General Co-Chair: Vincent G.-B. Lee, National Tsin Hua University, Taiwan

Technical Program Chair: Eric P. Y. Chiou, UCLA, USA

Organizing Chair: Aaron T. Ohta, University of Hawaii, USA

General Conference Info

The IEEE-NEMS is a key conference series sponsored by the IEEE Nanotechnology Council focusing on advanced research areas related to MEMS, nanotechnology, and molecular technology. Prior conferences were held in Suzhou (China, 2013), Kyoto (Japan, 2012), Kaohsiung (Taiwan, 2011), Xiamen (China, 2010), Shenzhen (China, 2009), Hainan Island (China, 2008), Bangkok (Thailand, 2007), and Zhuhai (China, 2006). For the first time, the conference will be held outside Asia. The conference typically has ~350 attendees with participants from more than 20 countries and regions world-wide.

Hawaii, USA

April 2014

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