Plenary Talk

Prof. Shanhong Xia

Institute of Electronics,Chinese Academy of Sciences

Title:

Research and Development on Micro Sensors and Systems

Abstract：

Sensors are the basic devices for information perception and acquisition. Miniaturization, integration, networking and intelligence are the important development direction of sensors. Microsensors and microsystems have experienced rapid development in recent decades, along with the discovery of new principles, the invention of new technologies, the emergence of new devices and the arising of new functions. MEMS based sensors have the advantages of small size, light weight, low power consumption and batch fabrication. They have been widely used in many fields.

This presentation will briefly review the development of sensors and microsystems, and then report the work of the presenter's team in the research and application of micro sensors and systems, mainly including MEMS based electric field sensors, chemical microsensors and systems for water environment monitoring, micro biosensor system-on-chip. The research background, working principle, design, fabrication, testing and application will be introduced, and the future development will be discussed.

Biography：

Professor Shanhong Xia received her B.Sc. degree from Tsinghua University, Beijing, China in 1983, her M.Sc. degree from the Institute of Electronics, Chinese Academy of Sciences (IECAS) in 1986, and her Ph.D. degree from Cambridge University, UK, in 1994. She received a Royal Fellowship from the Royal Society, UK in 1990 and a Berkeley Scholarship from the University of California at Berkeley, USA in 2002. She served as the General Chair and the International Steering Committee Chair at the 16th International Conference on Solid-State Sensors, Actuators and Microsystems (Transducers'2011), and worked as the vice-director of IECAS and the director of the State Key Laboratory of Transducer Technology. Now she is the director of the Institute of Photoelectric Technology, Beijing Institute of Collaborative Innovation, and a fellow and council member of the Chinese Institute of Electronics, vice-president of the Sensor Society and council member of the China Instrument and Control Society. She is a member of editorial board of the *IEEE Sensors Journal*, *Sensors & Actuators: A. Physical, Journal of Micromechanics and Microengineering, Microsystems & Nanoengineering*, *Nanotechnology and Precision Engineering*. Her research interests include sensors and microsystems, system-on-chip, wireless sensor network and micro/nano fabrications. Her current research mainly focuses on electric field microsensor, and integrated microsensor system for water pollution monitoring.

Prof. Tadatomo Suga

Meisei University

Title:

Surface activated bonding for micro system integration

Abstract：

The surface activated bonding (SAB) has been developed as a potential method for heterogeneous bonding at room temperature, attracting increasing interest due to its simple process flow, no need for additional intermediate materials for bonding, and compatibility with CMOS technology. The standard SAB method is based on surface bombardment by Ar beam in ultra-high vacuum to clean the surfaces so that they can be bonded very strongly at room temperature without heat treatment. The standard SAB, however, failed to bond some dielectric materials, such as glass and silicon oxide. A modified SAB was developed to solve this problem, by using an intermediate layer of Si, metals, or even metal oxide deposited on the activated surfaces. This modified SAB is now applied to bond not only SiO2 glasses but also polymer films such as PEN and Polyimide, as well as WBG semiconductor wafers to diamond substrate with a wide perspective of the applicability on heterogeneous integration for various microsystems.

Biography：

Tadatomo SUGA, Professor, Meisei University

He joined the Max-Planck Institut für Metallforschung in 1979, obtained his Ph.D. degree in materials science from University of Stuttgart in 1983. Since 1984 he has been a faculty member of the University of Tokyo, and has been a professor in the Department of Precision Engineering of the School of Engineering since 1993. He has been also the Chair of IEEE CPMT Society Japan Chapter, and the President of the Japan Institute for Electronic Packaging, as well as the Chair of JSPS University-Industry Cooperative Research Committee for Innovative Interface Bonding Technology. His research focuses on microelectronics and microsystems packaging, and development of key technologies related to low temperature bonding and interconnects. In the Marich of 2019, he retired from the University of Tokyo, being Professor Emeritus, and joined Meisei University to continue his research work.

Prof. Young-Ho Cho

Korea Advanced Institute of Science and Technology (KAIST)

Title:

Emotion monitoring skin patches for human mental healthcare

Abstract：

This talk presents human emotion monitoring skin patches, non-invasively measuring the physiological emotion symptoms appeared on human skin. Introduced are the motivation and technical issues involved in the development of skin-attachable multi-sensor patches for applications to non-invasive human emotion monitoring. Presented are the design, material and fabrication issues of the flexible skin patches to make conformal and trouble-free skin contacts for human emotion monitoring in daily-life. Also mentioned are the physiological symptom analysis, challenging to identify the signals effective for specific emotion and person, to evaluate personalized emotion indices, and to verify their statistical significance through human subject experiments. We discuss the relevance and difference between mental and physical healthcare issues, followed by the future directions, potential applications and importance of human mental health monitoring.

Biography :

Young-Ho Cho received his Ph.D. degree (1990), majoring in mechanical engineering and minoring in electrical engineering, from the University of California at Berkeley. Currently, Dr, Cho is the Professor of Bio and Brain Engineering Department at KAIST, where he has been active in N/MEMS research as the Director of Cell Bench Research Center as well as NanoSentuating System Laboratory at KAIST. He also leads National R&D Programs in Korea as the Directors of National Research Centers for Circulating Tumor Cells, National Laboratory for Human Emotion Monitoring Systems as well as the Head of National Growth Engine Headquarter of the Ministry of Science and ICT. For international society, Prof. Cho served as the Chairs of IEEE MEMS Conference 2003, World Micromachine Summit 2008, and International Power-MEMS Conference 2011. For Korean society, he served as the Founding Chair of MEMS Division in Korean Society of Mechanical Engineers, the Steering Committee Chair of Korea National MEMS Programs, the Executive Review Board for National R&D Programs, and the Planning and Adjustment Committee for National Science and Technology Council. Prof. Cho’s research achievements and contributions have been decorated with the Science and Technology Medal of Honor (2008) and the Order of Service Merit (2015) by the Republic of Korea.

Prof. Chengkuo Lee

National University of Singapore

Title:

Advance in human machine interfaces（HMI）for VR/AR applications

Abstract：

It has been reported that significant progress in energy harvesting technology in the past few years. By scavenging the wasted energy and converts it into electrical energy, the energy harvesting technology shows itself as a potential inexhaustible source for low-power devices. With such energy harvested from human activities, we can also use such energy to power up the wearable sensors and electronics. The piezoelectric and triboelectric nanogenerators have been investigated as the platform technologies for wearable self-powered sensors. The human machine interfaces (HMI) have been improved from tactile sensors, such as touchpads and joysticks, to now including the accurate detection of dexterous body movements in more diversified and sophisticated sensors. In this talk, we discuss a few triboelectric based HMIs including gloves, socks, soft robotic manipulator, and exoskeleton for object recognition, gaming, VR/AR applications, rehabilitation and digital twin applications. In addition, artificial intelligence (AI) as an effective data analytics tool has been integrated with various HMIs to achieve intelligent monitoring and recognition system. On the other hand, a smart floor monitoring system is reported with the merits of low cost and high scalability for smart home applications.

Biography：

Dr. Chengkuo Lee received his Ph.D. degree in precision engineering from The University of Tokyo, Tokyo, Japan, in 1996. Currently, he is the GlobalFoundries Chair Professor and director of Center for Intelligent Sensors and MEMS at National University of Singapore, Singapore. He cofounded Asia Pacific Microsystems, Inc. (APM) in 2001, where he was Vice President of R&D from 2001 to 2005. From 2006 to 2009, he was a Senior Member of the Technical Staff at the Institute of Microelectronics (IME), A-STAR, Singapore. He has co-authored 390+ journal articles and 360+ conference papers. He holds 10 US patents. His google scholar citation is more than 16800+. He is the Associate-Editor-in-Chief of Trans. Nanotechnology (IEEE), and editor-in-chief of Intern. J. Optomechatronics (Taylor & Francis). He is in the Executive Editor Board of J Micromechanics and Microeng. (IOP, UK). He is the Associate editor of J. MEMS (IEEE). He is also the Editor of next journals: Scientific Reports (Springer Nature), Bioelectronic Medicine (BMC, Springer Nature), Internet of Things - Engineering Cyber Physical Human Systems (Elsevier), J. Optical Microsystems (SPIE), Journal of Sensors (Hindawi), Sensors (MDPI), and Micromachines (MDPI). He has chaired many conferences including IEEE NEMS’18, OMN ’16 and ’14, ISMM’14, and Bio4Apps’13 etc.

Special Memorial Talk

Prof. Dong F. Wang

Jilin University

Title:

Micro/Nano Manufacturing and Its Applications - Under One Roof Report - Part VIII

Abstract:

The “Under One Roof Report” made its first appearance, later as Part I, in Jeju Island during the 2nd JCK in 2011. Since then, with the support of JCK Family of both committees and participants, the “Under One Roof Report” has been continued and kept improving until today as a series of conference reports, i.e., Part II (4th JCK in Sendai, 2013), Part III (6th JCK in Xi’an, 2015), Part IV (7th JCK in Sapporo, 2016), Part V (8th JCK in Seoul, 2017), Part VI (9th JCK in Dalian, 2018), and Part VII (10th in Asahikawa, 2019). Now this year, Part VIII has been relayed back to Xi’an once again.

The “Under One Roof Report – Part VIII” is the 2021 report of our group, Micro Engineering and Micro Systems Laboratory (JLU MEMS LAB), originally established in 2004 in Japan, and continued its international exchange culture value conception - Under One Roof with the world. As a fruit, more than 17 group members have started their Ph.D. or Joint Cultivating Programs etc. mainly at Tohoku University and The University of Tokyo, since 2017. Some of the latest research, such as nature-inspired spider-web design for energy harvesting, virtual-movement concept for eliminating spot positioning errors applicable to quadrant detectors, cantilever-based current sensing (CCS) methodology for multiphase current detecting and monitoring, as well as various smart sensing schemes with coupled oscillators for high-sensitivity mass sensing or for synchronous identification/detection of multiple traces are selectively introduced here for further applied research and possible industrial-academic-research cooperation.

All co-authors below,

Cao Xia, Xuesong Shang, Ziqi Zhao, Luwei Zheng, Wujie Fu, Shaokang Cheng, #Dong F. Wang*, Takahito Ono, Toshihiro Itoh, Ryutaro Maeda, and Masayoshi Esashi, contribute equally to the Part VIII.

Biography：

Dong F. Wang received a B.E. and a M.E. in materials science and engineering from Zhejiang University, China, and a Ph.D. degree in mechatronic engineering from Tohoku University, Japan. He was with Prof. Masayoshi Esashi at MEMS Laboratory of Tohoku University, where his research was focused on nano-machining of ultrathin hard films, nano-mechanics of ultrathin silicon resonators, and micro/nano magnetic mesa structures for all-silicon quantum computers. Since 2014, he has been a Leading Professor/Head with the Micro Engineering and Micro Systems Laboratory (JML), Jilin University, China. He authored two international book chapters in Micro Electro Mechanical Systems (Springer, 2018), published 200+ peer-reviewed articles in international journals, including MSSP, TIE, TIM etc., and conference proceedings, holds 40+ Chinese patents and 2 Japanese patents, and given 20+ invited presentations in universities/institutes and 10+ keynote/plenary addresses at international conferences. His research interests include fundamental studies with a focus on Non-linear Micro/Nanoelectromechanical Systems (NMNS). He received several awards from Japan, USA, and China, and serves as General Chair, Co-Chairman etc. for 10+ international conferences, and as contributing reviewer for 30+ SCI indexed journals. He is one of the founders of the Annual IEEE NEMS since 2006, as well as the Japan-China-Korea Joint Conference on MEMS/NEMS dated back to 2006. His group is also collaborating with researchers from Tohoku University, The University of Tokyo, as well as National Institute of Advanced Industrial Science and Technology in Ubiquitous MEMS and Micro Engineering. He is a Senior Member of CMES, CSMNT, a Member of IEEE, JSME (Japan), IEEJ (Japan), Japan Society of Next Generation Sensor Technology, and MEMS Industry Forum.

Invited Talk

Dr. Daniel Zymelka

National Institute of Advanced Industrial Science and Technology

Title:

Automated Sensing Systems Based on Printed Strain Sensors for Monitoring of Civil Engineering Structures

Abstract:

With the ever-growing trend toward urbanization, civil infrastructure is expanding rapidly around the world. However, the new constructions and gradual deterioration of those already existing, especially bridges, give rise to concerns about their proper maintenance. Therefore, to improve safety and drive down maintenance costs of civil engineering structures, there is a need for sensing systems capable of reliable and automated monitoring. To address this problem, this study aimed at the development and evaluation of screen-printed strain sensors for applications in structural health monitoring (SHM). The sensors were arranged into a form of an array printed onto a flexible substrate. Such prepared devices were integrated with a dedicated wireless data acquisition system which enables remote and automated measurements under real-life conditions. The sensing system was deployed on various types of civil engineering structures (bridges and a gravity dam) for a few-months-long operation. The use of the sensor arrays relies on comparative analysis of measured output signals from all sensors in the array, looking for strain anomalies, which are early damage indicators. Besides the capability of the developed sensors for damage detection, fundamental studies on strain sensitivity, durability, long-term stability, and sensitivity to temperature changes were carried out. The results show that printed sensors incorporated into automated data acquisition systems can be used as complementary sensing systems to those already existing within the framework of SHM. This indicates the potential new practical application area for the printed strain sensors in monitoring civil engineering structures.

Biography:

Daniel Zymelka is a Research Scientist at the National Institute of Advanced Industrial Science and Technology (AIST), Japan. He received his degree in Materials Science from the Jagiellonian University (Poland) in 2008, and his Ph.D. from Ecole des Mines de Saint-Étienne (France) in 2012. In 2011 he joined the Centre of Microelectronics in Provence (France), where he started his research on selective sintering methods for applications in flexible printed electronics. In 2015 he joined AIST and initiated research into the development of networked sensing systems based on printed electronics for applications in structural health monitoring. He currently focuses on additive fabrication methods and the development of new sensors using printed stretchable electronics.

Prof. Ken-ya Hashimoto

University of Electronic Science and Technology of China

Title:

Recent Progress of RF Acoustic Wave Devices Gifted by MEMS Technologies

Abstract：

65 years have been passed from the first report on surface acoustic wave (SAW) devices, and 41 years from proposal of thin-film-based bulk acoustic wave (BAW) resonators. Nevertheless, these devices still keep on evolving in surprisingly high speed to fulfill severe demands given by the market. Various MEMS technologies have been applied to these devices, and the hottest topic for last five years is use of extremely thin piezoelectric layer realized by the wafer bonding.

This talk is aimed at overviewing recent progress of SAW/BAW devices for the mobile phone market. First, the market trend is surveyed to explain why extremely high performance RF SAW/BAW devices are necessary. Then a SAW device using very thin piezoelectric layer is introduced, and it is shown how drastic improvement was given by the use of wafer-bonding technology. Finally, recent research trends on RF SAW/BAW devices are given. They are also based on very thin piezoelectric layers and intended to application to 5G/6G systems.

Biography：

Ken-ya Hashimoto was born in Fukushima, Japan, on March 2, 1956. He received his B.S. and M.S. degrees in electrical engineering in 1978 and 1980, respectively, from Chiba University, Japan, and his Dr. Eng. degree from Tokyo Institute of Technology, Japan, in 1989. In 1980, he joined Chiba University as Research Associate, and retired there as Professor Emerius in 2021. In the same year, he joined the University of Electronic Science and Technology of China, Chengdu, China, as Professor.

He was a Visiting Professor in many Universities such as Helsinki University of Technology, Finland, Johannes Kepler University of Linz, Austria, and Shanghai Jiaotong University, Shanghai, China.

He was chosen as an IEEE Fellow (2005) and received numerous awards such as the International Distinguished Lecturer Award from the IEEE UFFC Society (2005), the Ichimura Industrial Award from the New Technology Development Foundation (2015), The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology (2018), and IEEE UFFC Distinguished Service Award (2019).

His current research interests include simulation and design of various high-performance surface and bulk acoustic wave devices, acoustic wave sensors and actuators, piezoelectric materials and RF circuit design.

Prof. Norihisa Miki

Keio University

Title:

Micro-Nano Technology/Concept-Based Medical & Healthcare Devices

Abstract:

Micro-nano technologies enables us to manufacture micro-nano functional structures of a wide variety of materials. This opens up the new design spaces of the innovative devices. Not only the technologies but also the concept often lead to new inventions. In this presentation, I introduce two devices: Azinzo and Saltchip.

Azinzo is an implantable artificial kidney that will drastically improve QOL of the dialysis patients. It is composed of multi-layered micro channels that are separated with nanoporous dialysis membranes. Azinzo filters blood to remove water and low-molecule-weight ions, which are transferred to the bladder and discarded as urine. I will be introducing the most recent results and in addition, the challenges that we have encountered.

Saltchip is an adhesive chip-size polymeric material. It contains a minute amount of salt and can be attached to the backside of a tooth or the upper jaw. It gradually dissolves and deliver sodium ion to taste receptors on a tongue rather directly. This invokes strong salt taste despite the small amount of salt included in the saltchip. We can eat and drink with the saltchip attached, which can enhance the salt taste. This will help salt intake reduction, which is necessary for high-pressure and kidney patients. The idea of saltchip was inspired by the drug-delivery technology; by positioning a drug in the vicinity of the diseased parts, the amount of the drug can be reduced and thus the side effect of the drug can be alleviated.

In order to deliver these two devices to the users, they need to be commercialized. We founded LTaste inc. to sell the saltchip and are planning to found Azinzo inc. for Azinzo. As a matter of course, we have encountered many challenges, some of which originate

from the characteristics of the fields. I am going to share the lessons learnt with the audience.

Biography：

Norihisa Miki received Ph.D. in mechano-informatics from University of Tokyo in 2001. He developed a world-smallest drone using MEMS technology during his Ph.D. Then, he worked at MIT microengine project as a posdoc (2001-2003), later as a research engineer (2003-2004). He joined the Department of Mechanical Engineering at Keio University in 2004 as an assistant professor and became a full professor in 2017. His research interests started with development of MEMS-based biomedical and human interface devices. Currently, he also explores the fields of medical engineering, neuroscience, and media arts using his innovative devices. He was a researcher of JST PRESTO (Information Environment and Humans) from 2010 to 2016 and Kanagawa Institute of Industrial Science and Technology (formerly, Kanagawa Academy of Science and Technology) from 2010 to present. He is a member of IEEE and JSME micro-nano science and technology division. He is a general chair of the 8th and 9th Symposium on Micro-Nano Science and Technology in 2017 and 2018 sponsored by JSME. He co-founded a healthcare startup LTaste Inc. in 2017. He is a Director of Keio Ice Skating Club.

Prof. Zhou Li

Beijing Institute of Nanoenergy and Nanosystems

University of Chinese Academy of Sciences

Title:

Self-powered electronic medical devices and electrical stimulation therapy

Abstract：

Electrical activity is the basis of human life activities. Regulating electrical activity changes the excited and inhibited states of cells, tissues and organs to treat diseases. Nanogenerators are the new type of energy conversion device that convert low-frequency mechanical energy into electrical energy. In addition, it has gained the attention of researchers because of the flexibility, spinnability, high-output voltage, structural and material diversity. We employed nanogenerators to efficiently convert the mechanical energy of human motion into electrical energy and supply power to electrical stimulation devices and biosensors. Then, we developed self-powered electronic medical devices and medical sensors to carry out more systematic research work. For example, the power generated from the heartbeat can be used to drive the cardiac pacemaker to work for a long time, construct symbiotic cardiac pacemaker, as well as complete the research on improving heart rate and treating arrhythmia in the large animal experiments for the first time. Degradable self-powered electrical stimulation devices are used to regulate the growth direction of nerve cells, enhance intercellular integration and regulation of cardiomyocytes, promote osteoblasts proliferation and differentiation, accelerate skin wound healing. Besides, the devices can be completely absorbed by the body after the disease treatment. There are researches on self-powered cardiovascular biosensors that can realize minimally invasive implantation and have good biocompatibility. These researches focus on self-powered electronic medical devices and electrical stimulation therapy, and have important potential to be transformed into electronic medical devices and medical sensors for clinic treatment.

Biography：

Zhou Li is full Professor in Beijing Institute of Nanoenergy and Nanosystems and School of Nanoscience and Technology, University of Chinese Academy of Sciences, Chinese Academy of Sciences. He received Ph.D. degree from Peking University in 2010, and bachelor degree from Wuhan University in 2004. He studied in Georgia Institute of Technology from 2007 to 2009. He was Associate Professor in School of Biological Science and Medical Engineering, Beihang University from 2010-2015. His research interest focused on bioelectronics, self-powered medical system, nanogenerators, implantable energy harvesting devices, single cell mechanics and nano-biosensors.

Prof. Li has published more than 140 peer-review articles in Nature Rev. Cardio., Sci. Adv., Nature Comm., Adv. Mater., Adv. Energy Mater., Nano Lett., Adv. Funct. Mater., ACS Nano, Nano Energy, Ann. Rev. of Biomed. Engin., Adv. Sci., Small, Research, Adv. Health. Mater. and Sci. Bull. et al. and have been cited more than 7000 times, H-index 45. Prof. Li have 29 granted patents. Prof. Li have been awarded Science and Technology Award of Beijing, “Young Investigator’s Award” of International Federation for Medical and Biological Engineering (IFMBE) and Gold Award of China Association of Inventions. Prof. Li is the Vice-Chairman of Youth Committee in the China Society of Biomedical Engineering, the Young Vice-Chairman of the Life Electronics Branch of the Chinese Institute of Electronics, and the Youth Committee member of the China Society of Biological Engineering. He is supported by the National Science Fund for Distinguished Young Scholars, Beijing Natural Science Foundation for Distinguished Young Scholars, National Youth Talent Support Program, the New Century Excellent Talents of Ministry of Education of China, Beijing Top-notch Talent Program, and Beijing Nova Program. He is Associate Editor of Science Bulletin, Smart Materials in Medicine, Nano Select and Current Applied Materials, Guest-editor of Advanced Functional Materials, InfoMat and the Editorial board member of Sensors and Actuators Report and Life Science Instrument. He is also invited reviewer for more than 70 SCI journals, including Nature Biomedical Engineering, Nature Electronics, et al.

Prof. Zhikang Li

Xi'an Jiaotong University

Title:

Design, modeling, fabrication and application of micromachined ultrasonic transducers

Abstract：

Ultrasonic transducers harness ultrasound waves to realize different types of sensing functions, which features the merits of non-invasive detection and biocompatibility, enabling their widespread applications in clinic medical imaging, industrial nondestructive testing, ultrasonic three-dimensional (3D) biometrics identification and 3D ultrasonic gesture recognition. However, most of commercially available transducers are based on bulk PZT, suffering from large size, significant acoustic impedance mismatch and difficulty to fabricate two-dimensional (2D) arrays for 3D ultrasonic imaging. Micromachined ultrasonic transducers (MUTs) take advantages of MEMS fabrication technologies, featuring small size, easy fabrication of 2D array and integration with integrated circuits (ICs), as well as better acoustic impedance mismatch with fluid and human tissue in comparison with conventional PZT-based ultrasonic transducers. These advances make MUTs a promising alternative to conventional transducers in aforementioned applications. To date, numerous efforts from different institutes over the world have been put on research of MUTs.

MUTs can be categorized into two types: capacitive micromachined ultrasonic transducers (CMUTs) and piezoelectric micromachined ultrasonic transducers (PMUTs). This talk is aimed at overviewing the advance in the design, modeling, fabrication and application of CMUTs in our group. First, the structure design and theoretical modeling of CMUTs are introduced, to show how the performances such as output acoustic pressure, electromechanical coefficient and collapse voltage are improved. Then, the low-temperature wafer bonding-based fabrication technologies of CMUTs is presented, which solves the obstacle between the integration of CMUTs

with ICs. Finally, several typical applications of developed CMUTs are given to show their appealing potential.

Biography：

Zhikang Li received the B.S. degree in mechanical manufacturing and automation from Xidian University, Xi'an, China, in 2010, and the Ph.D. degree in mechanical engineering from Xi'an Jiaotong University, Xi'an, in 2017. From 2014 to 2015, he was with the group of Professor Liwei Lin at the University of California at Berkeley, Berkeley, CA, USA, as a jointly cultivated Ph.D. student, for one year. Since 2018, he has been an Assistant Researcher with the group of Prof. Ali Khademhosseini at the Department of Bioengineering, University of California at Los Angeles, Los Angeles, CA, USA. He is currently an Assistant Professor with the School of Mechanical Engineering, Xi'an Jiaotong University.

His research interests include nano-electromechanical systems (NEMS)/

micro-electromechanical systems (MEMS) sensors, capacitive micromachined ultrasonic transducers (CMUTs), piezoelectric micromachined ultrasonic transducers (PMUTs), skin-like electronics and wearable sensors.

Prof. Bo Chang

Shaanxi University of Science and Technology

Title:

Low-cost Laser Micromachining Super Hydrophilic - Super Hydrophobic Microgrooves for Capillary Micromanipulation of Microfibers

Abstract：

Microfibers are important components for manufacturing fiber reinforced materials, and their orientation has a significant impact on their mechanical, electrical, and thermal properties. However, in the micro world, the adhesion force dominates gravity due to the scaling law, making accurate micromanipulation of the microfibers challenging. Methods for micromanipulation of fibers includes electrospinning, 3D printing, robotic micromanipulation, microfluidics, and so on. Despite of the abundance of available methods, precisely controlling the spacing and orientation of microfibers remains a challenge hampering the construction of complex patterns from microfibers.

This work suggests a simple and low-cost laser micromachining method for fabrication of super hydrophilic-super hydrophobic grooves for capillary self-alignment of microfibers. We investigated key manufacturing parameters and its effect on the sizes and wetting properties of the microgrooves. We studied the influences of the width (20 μm - 100 μm), the depth (8 μm – 36 μm) on the volume of water droplet confined inside the grooves. The results reveal that the groove's width and depth are proportional to the number of scanned lines and scans, respectively. We further demonstrated that by adjusting the scanning speed of a de-focused laser beam, we can change the microgrooves' wetting properties from 10° to 120°. We demonstrated that diverse types of microfibers, including both natural and artificial microfibers, can self-align to super hydrophilic -super hydrophobic microgrooves. The results suggest that super hydrophilic – super hydrophobic microgrooves have great potential in microfiber micromanipulation applications such as natural microfiber categorization, fiber-based microsensor construction, and construction of fiber-enforced material.

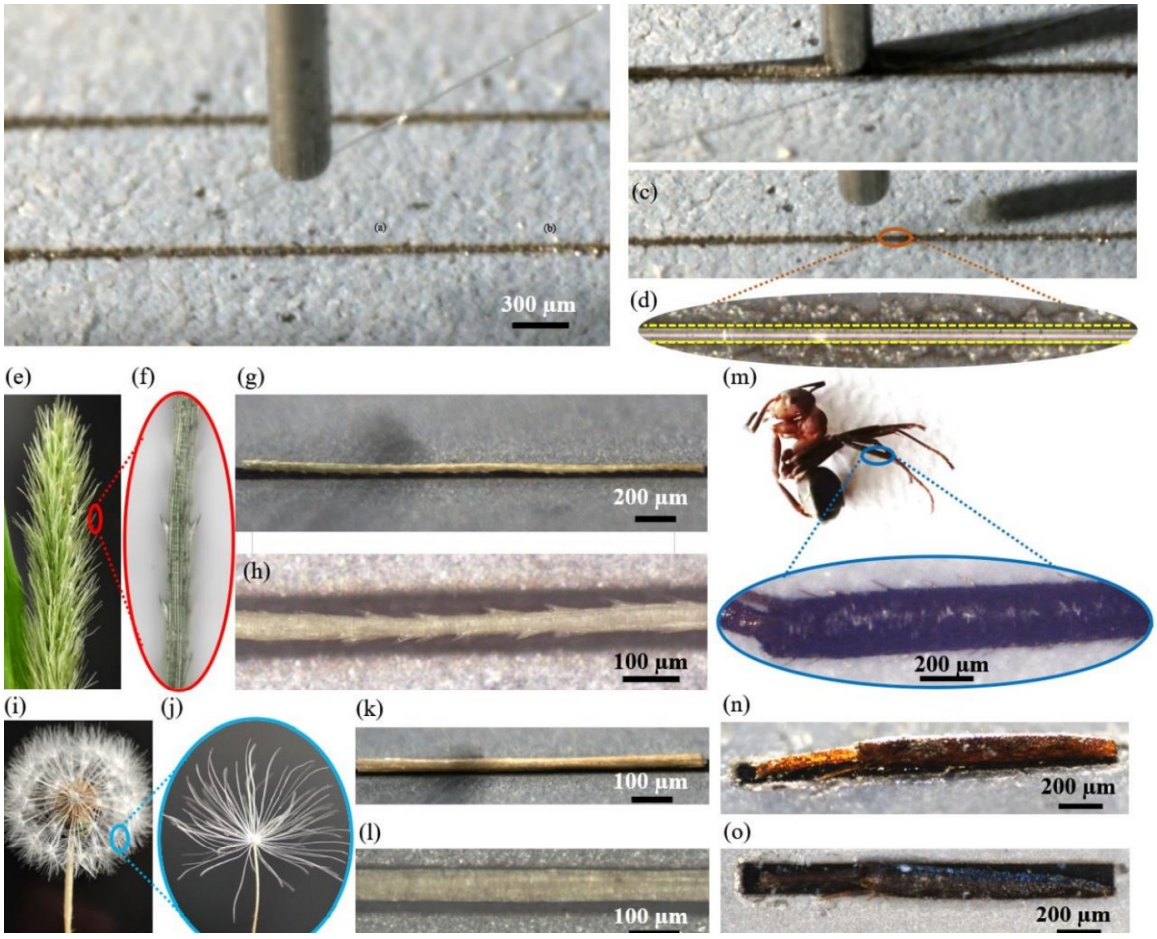

Fig. 1 Demonstration of capillary self-alignment of different types of microfibers on shape matching super hydrophilic – super hydrophobic grooves.

Biography：

Dr. Bo Chang received the M.S. degree in automation technology from Tampere University of Technology, Finland, and the Dr. Tech. degree in electrical engineering from Aalto University, Finland.

From 2013 to 2016, Dr. Bo Chang was a Finnish Academy Postdoctoral Researcher with the Robotic Instruments Laboratory, Aalto University, Finland. In 2014-2016, she was a Visiting Scholar at the Division of Microsystem Technology, Uppsala University, Sweden. Since 2017, she has been a Professor with the School of Mechatronics Engineering, Shaanxi University of Science and Technology. She was nominated as Shaanxi Hundred Young Talents in 2017. She is leading the Multiscale Mechatronics Research group.

Dr. Bo Chang has authored or co-authored more than 50 publications in international scientific journals and international conferences, in the field of micromanipulation and microfabrication. Dr. Bo Chang also has long experiences of international research projects, including EU Project HYDROMEL, a cooperative project on combining robotic methods and self-assembly for micro- and nano scale components, with 24 partners from 11 European countries, and FAB2ASM, a cooperative project on 3D integration and optoelectronics, with 9 partners from 6 European countries. National research projects Dr. Bo Chang has participated or was PI include projects supported by Academy of Finland (AKA), Finnish Funding Agency for Technology and Innovation (TEKES), National Natural Science Foundation of China (NSFC).

Dr. Bo Chang’s current research interests include robotic microassembly, self-assembly, micromanipulation, micro robots, microfabrication and applications.

Prof. Dezhi Wu

Xiamen University

Title:

Additive Manufacturing of Micro/Nano Structures for Flexible Sensors and Actuators

Abstract:

Micro/Nano structures are building blocks of most sensors, flexible displays, biological tissues and intelligent robots etc. However, most fabrication methods including CVD and screen printing are unable to build micro/nano structures with diverse materials and multi-dimensions (dots, lines and films etc), which are needed in many applications. Additive manufacturing technologies, especially electrohydrodynamic printing (EHDP), are simple yet versatile to fabricate micro/nano structures. Here we will introduce some advance of EHDP technology involving Weissenberg effect based printing and massive electrospinning etc. in our lab. Also fabrication of some flexible sensors and actuators such as flexible pressure sensors and intelligent soft robots will be discussed.

Biography:

Dezhi Wu is a professor at Xiamen University, China. He received his doctoral degree in Measurement & Metrology Technology and Instrumentation from Xiamen University (China) in 2009 after he got Master degree from Wuhan University of Technology (China). In 2015, he did research as visiting scholar in University of California at Berkeley (UCB). His research interests include micro/nano fabrication and flexible sensors/actuators. Till now he has published more than 60 papers and more than 16 patents have been issued.

Dr. Dae-Sik Lee

Electronics and Telecommunications Research Institute (ETRI)

Title:

Biochemical sensor device using exhaled breath for mobile health monitoring

Abstract：

I will present on how we have designed, fabricated, characterized and tried to industrialize the olfactory sensor systems using the BioMEMS technologies through talking about small and several research and development cases. I will present three small stories concerning gas sensor devices technologies, application studies on early lung cancer screenings, and diet-monitoring for mobile healthcare First, as for sensing materials and gas sensors, it is important to accomplish high sensitivities which can detect under a ppm and high selectivities that can detect with excellent specificity. We employed the nano-structured metal oxides materials as sensor materials. I will introduce briefly the recent research results of ours. Secondly, the electronic nose technologies will be presented for early lung cancer diagnostics, along with some gas sensor studies. Through some technical and business procedures, we are starting a startup company, as an ETRI research startup company through ETRI-holdings. Third, the electronic nose technologies for diet monitoring will be presented with clinical testing results. We believe that the sensor-based revolutionary methods could contribute to accelerate the acceptance of mobile healthcare as a practical tool in point of care.

Biography：

Dae-Sik Lee is a principal researcher/project leader in the Bio-Medical IT Convergence Research Division at ETRI and was an associate professor of Department of Computer Software at University of Science and Technology (UST), Daejeon, Rep. of Korea. He received his PhD in electronic engineering under the supervision of Duk-Dong Lee professor from Kyungpook National University (Korea) in 2000, and the other PhD in nanoscience and nano-engineering under the supervision of Shuich Shoji professor in the Department of Electronic and Photonic System, Waseda University (Japan), 2009. He did some technology transfers and cofound three companies by technology investment through ETRI holding company, and two among them got IPO (initial public offering) successfully in KOSDAQ, 2019 and 2021, respectively. Current research interests include the design, fabrication, and characterization of BioMEMS and biochemical devices, Gas Sensor and Systems, microfluidic devices, nano-engineering, sensor array, and their systems.

Dr. Do Hyun Kang

Korea Institute of Machinery and Materials

Title:

Advanced Optical Biosensor Platforms Based on Smart Nanomaterials

Abstract：

In this talk, I will introduce my biosensor researches using two functional materials, conjugated polydiacetylene (PDA) liposomes and metal-free phosphorescence materials.

A conjugated polymer, polydiacetylene (PDA) has an interesting optical property which can change its color from blue to red and emit red fluorescence on exposure to various external stimuli (e.g., heat, chemicals, and biomolecules). Due to this colorimetric response, PDAs have been an attractive material to construct label-free biosensor systems. I have integrated this PDA material to microarray, microbead, or paper-based microfluidic devices, realizing convenient point-of-care kits for detection of platelet function, cancer biomarker, antibody, toxic antibiotics (neomycin), and heavy metal ions.

Phosphorescence materials are another attractive material to develop biosensor systems having high-sensitivity and low signal-to-noise ratio. For the phosphorescence biosensor applications, I have developed a lipid-polymer hybrid nanoparticles having metal-free organic phosphors with a simple nanoprecipitation-based fabrication method. In addition, I have successfully applied this phosphorescence nanoparticles to the cell-free DNA detection and *in vivo* retinal oxygen monitoring.

Biography：

I am currently a senior researcher at Korea Institute of Machinery and Materials (KIMM) in the department of nano-manufacturing technology. I received my Ph.D. degree at the Seoul National University (SNU) in the mechanical engineering, under the direction of the late Prof. Kahp-Yang Suh and Prof. Noo Li Jeon, in 2014. I was a postdoctoral researcher at University of Michigan, Ann Arbor, in the materials science and engineering, under the supervision of the Prof. Jinsang Kim, from 2015 to 2019. I have joined KIMM since 2019. I have productively studied on diverse topics related to design, fabrication, and device integration of functional materials at the molecular/nano/micro scale for biomedical applications. One of my representative researches are high-sensitive, colorimetric biosensor systems (e.g., microarrays, microbeads, microfluidic chips) based on conjugated polydiacetylene liposomes or metal-free phosphorescent materials. In addition to my biosensor work, I have also enjoyed researches related to design and fabrication of microfluidic devices and microreactors.

Dr. Chung-Soo Kim

Korea Institute of Industrial Technology

Title:

Additively Manufactured Multi-Component Sputtering Target for Tribological Thin Film Physical Vapor Deposition Application

Abstract:

Additive manufacturing is one of the important manufacturing technologies in the age of digital transformation and is also the heart of the fourth industrial revolution. Generally, AM has been used to not only manufacture mechanical components directly, but also manufacture molds to produce massive numbers of components indirectly. In this talk, we introduce new applications of the additive manufacturing as a consumable for thin film physical vapor deposition techniques, i.e., sputtering target for magnetron sputtering. Unlike traditional sputtering target manufacturing processes such as hot pressing, spark plasma sintering, and so on, we utilized directed energy deposition techniques in order to manufacture multi-component sputtering targets of ZrCuSi for current and future automotive applications from internal combustion engines and electric motors. This ZrCuSi has been used to reduce wear and friction by forming ZrCuSiN thin films via a physical vapor deposition. We had successfully demonstrated additive manufacturing of ZrCuSi sputtering target and this target proved its functionality in terms of hardness and friction characteristics. We further showed its sustainability by repairing it for recycling. We anticipate that this approach can be utilized in various physical vapor deposition applications in functional coatings and microsystems, e.g., micro and nano electromechanical systems.

Biography:

Chung-Soo Kim is currently a Senior Researcher at Korea Institute of Industrial Technology (KITECH), South Korea. He received his Ph.D in mechanical and aerospace engineering from Seoul National University in 2013. In 2013 he joined Research Laboratory of Electronics at Massachusetts Institute of Technology and continued his research on a single nano-digit nanofabrication and non-demolition quantum electron microscope. In 2017 he joined Global Technology Center at Samsung Electronics and worked for advanced manufacturing technologies and digital transformation. In 2019 he joined KITECH and now working on design for manufacturing, additive manufacturing and advanced manufacturing technologies based on electron, ion, and photon beam technologies at various length-scale.

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Prof. Binbin Jiao

Institute of Microelectronics of The Chinese Academy of Sciences

Title:

Thermal & Stress Test Vehicle for Integrated Circuit Packaging

Abstract:

In recent years, with Moore's law gradually coming to an end, the development of integrated circuit chips began to show two trends: heterogeneous integration and monolithic system on a chip. These trends raise new challenges to the packaging technology of integrated circuits. In order to meet the detection requirements of temperature and stress distribution caused by chip self-heating, a special sensor has emerged. This report briefly describes the development history of such sensors and introduces the progress of our group in this field. The developed test chip has the characteristics of high-resolution, high-power density, wide temperature measurement range and high stress sensitivity. The multichannel drive system and multichannel readout system matched with the chip are developed. Finally, several application examples of the test vehicle in chip packaging and chip cooling are introduced.

Biography:

Prof. Binbin Jiao, Head of Research Group, Institute of Microelectronics of The Chinese Academy of Sciences. He received his B.S. in Electronic Science and Technology from the Xi'an Jiaotong University in 2003, and his Ph.D. from Institute of Microelectronics of The Chinese Academy of Sciences in 2008. His group's expertise covers MEMS devices, Microsystems, CMOS-MEMS process development, and Microchannel cooling for chips. He has participated in a number of National projects as National High Technology research and Development Program of China, Chinese Equipment Pre-Research Field Foundation Key Project, and obtained a number of financial supports including Hislicon, Miramems and Dali Technology.