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JCK MEMS/NEMS 2024

The 15th Japan-China-Korea Joint Conference on MEMS/NEMS

Conference Handbook

September 19-21, 2024
Chengdu CHINA

micromachines

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JCK MEMS/NEMS 2024

Guest Editors:

Prof. Dr. Zhuqing Wang
School of Mechanical Engineering, Sichuan University, China

Prof. Dr. Norihisa Miki
Department of Mechanical Engineering, Keio University, Japan

Dr. Jeongdai Jo
Department of Flexible and Printed Electronics, Korea Institute of Machinery and Materials, Republic of Korea

Deadline for manuscript submissions:
31 December 2024

Message from the Guest Editors

Dear Colleagues,

This Special Issue will publish selected papers from the 15th Japan-China-Korea Joint Conference on MEMS/NEMS (JCK MEMS/NEMS 2024, www.jckmemsnems2024.com), 19–21 September 2024 in Chengdu, China. The conference will cover the following main topics:

- Micro/Nano Electro-Mechanical Systems (M/NEMS);
- Micro/Nano-Fabrication including 3D printing;
- Micro/Nano-Actuators and Robotics;
- Micro/Nano-Chemical and Physical Sensors;
- Micro/Nano-Bio Devices and Systems;
- Micro/Nano-Electronics including Flexible Electronics;
- Micro/Nano-Enabled Wearable Devices;
- Networked Microsystems and IoT Technologies;
- Materials and Device Characterization;
- Integration and Packaging Technologies;
- Modeling and Simulation of Manufacturing Processes;
- Medical Engineering Technology.

Papers attracting the most interest at the conference, or that provide novel contributions, will be selected for publication in *Micromachines*. These papers will be peer-reviewed for validation of research results, developments and applications.

In addition, submissions from others that are not associated with this conference but with themes focusing on MEMS/NEMS technology are also welcome.

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Special Issue

Develop

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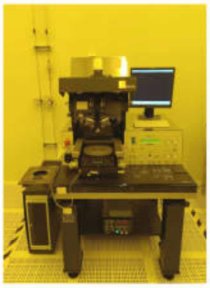
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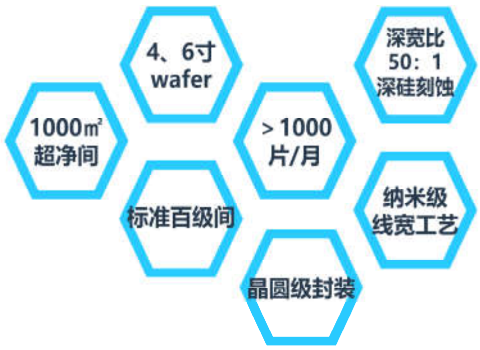

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Design and Application

Content

Welcome Message

Welcome to JCK MEMS/NEMS 2024

On behalf of all the committee members of JCK MEMS/NEMS 2024, we extend our gratitude to the guest speakers, co-organizers, and supporters of the upcoming conference scheduled from September 18 to September 21, 2024, in Chengdu,China. Since 2010, the JCK MEMS/NEMS has been committed to sharing research accomplishments and enhancing strategic collaborations for the betterment of East Asian society. The conference aims to serve as an annual East Asian platform for discussing advancements in MEMS/NEMS technology, with a focus on fostering international partnerships to address environmental and social challenges in the region.

As the world evolves, the exchange and advancement of science and technology become increasingly crucial. This year, the conference baton passes to China, and we cordially invite you to the 15th Japan-China-Korea Joint Conference on MEMS/NEMS (JCK MEMS/NEMS 2024) to be held in Chengdu, China. Given the growing significance of "Medical Engineering Technology" across various sectors, JCK MEMS/NEMS 2024 will center around Micro/Nano Electro-Mechanical Systems to explore how MEMS/NEMS can aid in medical and industrial integration.

We express our appreciation to the esteemed guest speakers who will be presenting despite their busy schedules. Anticipating an engaging and insightful scientific program, we look forward to facilitating networking and idea-sharing opportunities for all attendees. With your participation, we are confident that JCK MEMS/NEMS 2024 will be a rewarding and memorable experience for everyone, set against of the backdrop of the vibrant city of Chengdu.

Conference General Chair of JCK MEMS/NEMS 2024

Ph.D., Zhuqing Wang

Sichuan University, China

The 15th Japan-China-Korea Joint Conference on MEMS/NENS

（JCK MEMS/NEMS 2024）

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Notes for Participation

Dear Participants:

Welcome to the 15th China-Japan-Korea Joint Conference on Micro-Nano Electromechanical Systems (JCK MEMS/NEMS 2024)! To ensure smooth participation, please read the following notes carefully.

I. People's basic needs

Weather	The average temperature in Chengdu in September is 24° C
Food	● Meals will be served to participants during the meeting ● Meals: Lunch/dinner on the 19th, lunch on the 20th ● Dining place：Jinjiang Hotel 2F Jinjiang Hall ● Lunch place: Jinjiang Hotel 1F Zizhu canteen
Lodging	The conference provides hotel reservation service, please visit the conference website to make reservations at your own expense.
Transport	Plase refer to “Transportation Guide”

II. Session venue

No.80, Section 2, Renmin South Road, Jinjiang District, Chengdu (160 meters walk from Exit B of Jinjiang Hotel Metro Station)

III. Registration Reporting

Time: September 18, 2024, 13:00-22:00 Jinjiang Hotel

Hint: Students and member delegates should bring their identification documents, otherwise they will be registered according to the standard of ordinary delegates.

IIII.Attention

•Participants are requested to wear their Session credentials when entering the Session ;

•Computers will be available at all Sessions, and presenters are requested to enter the Session in advance to copy their PPTs to the Session computers;

•Participants are requested to enter the Session on time according to the Session schedule and turn their cell phones to silent or vibrate status;

•Please take good care of your belongings during the Session to avoid losing them;

•To improve the efficiency of check-in, please arrive early and check-in in an orderly manner.

V. Contact information for the conference services team

Telephone 1: +86 15884501720 （Mr. Xia）

Telephone 2: +86 18406589504 （Mrs. Zhao）

Have a great trip to the conference!

Organising committee of JCK MEMS/NEMS 2024

September 2024

Transportation Guide

Address: Sichuan Jinjiang Hotel

Address: No.80, Section 2, Renmin South Road, Jinjiang District, Chengdu (160 meters walk from Exit B of Jinjiang Hotel Metro Station)

Hotel Reception： (Telephone) +86 028-85506666

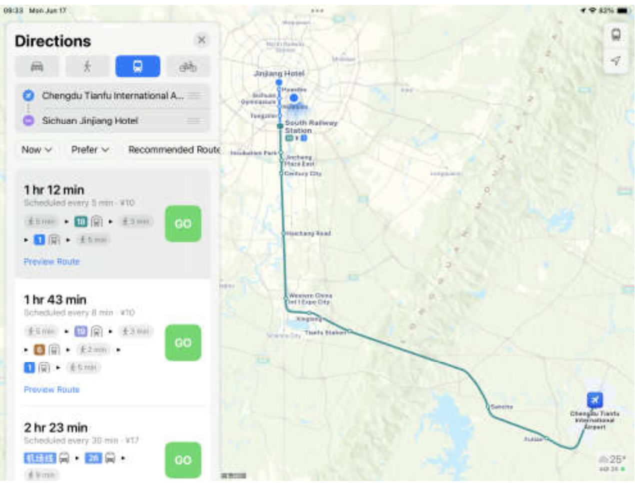
General graphical overview:

Directions:

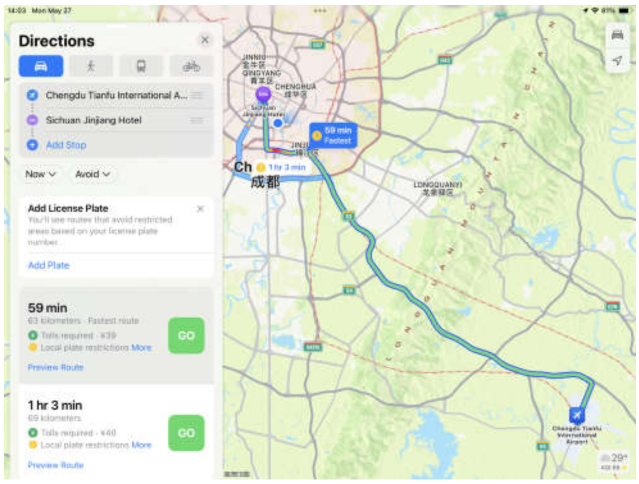
I. Chengdu Tianfu International Airport to Jinjiang Hotel

1. **Subway:** Line 18 (Tianfu Airport Terminal 1 and 2 station -- South Railway Station), transfer to Line 1 (South Railway Station -- Jinjiang Hotel Station)

2. **TAXI:** about 1hour, 90-110 CNY。



1.Subway routes

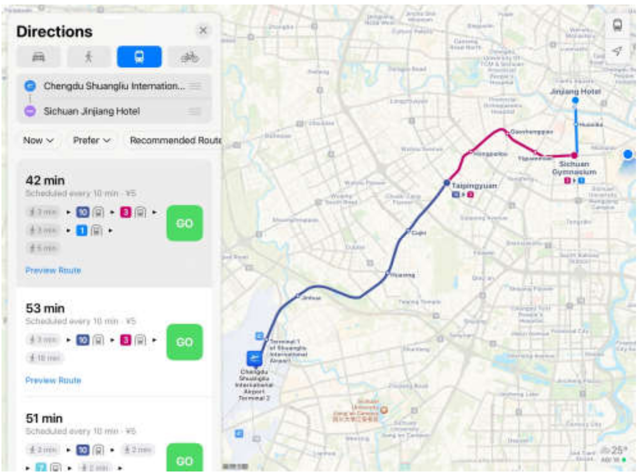


2. TAXI routes

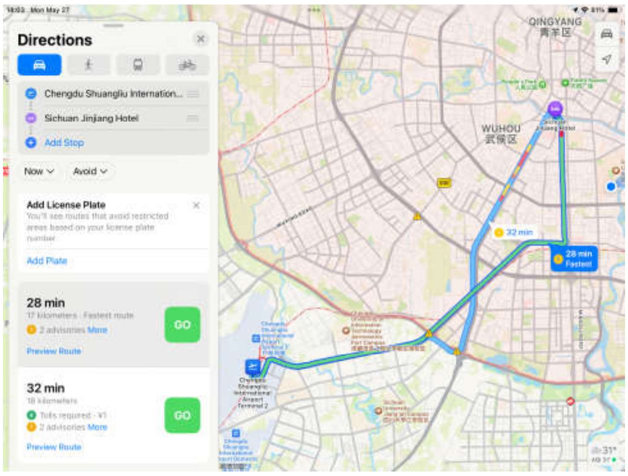
II. Chengdu Shuangliu International Airport to Jinjiang Hotel

1. Subway: Take Line 10 (Shuangliu Airport Terminal 1 Station -- Taiping Yuan Station), then transfer to Line 3 (Taiping Yuan Station -- Provincial Stadium Station), and finally take Line 1 (Provincial Stadium Station -- Jinjiang Hotel Station).

2. Taxi： about half an hour, 30-40 CNY。



1.Subway routes

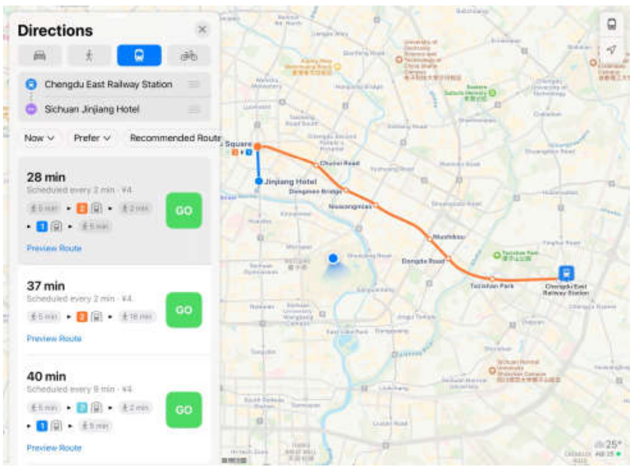


2. TAXI routes

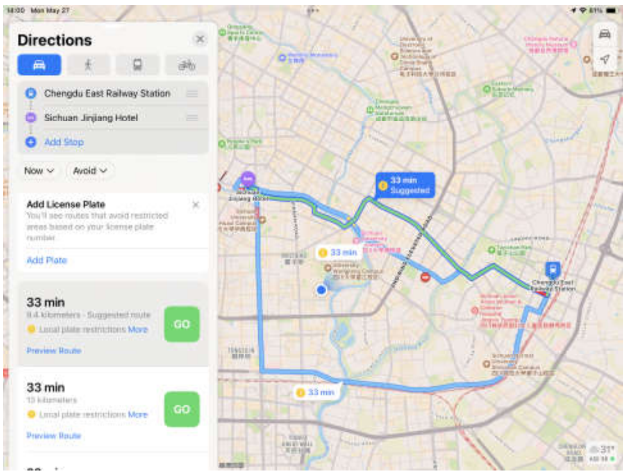
III. Chengdu East Railway Station - Jinjiang Hotel

1. Subway: Take Line 2 (Chengdu East Railway Station -- Tianfu Square Station), then change to Line 1 (Tianfu Square Station -- Jinjiang Hotel Station).

2. Taxi: about 20 minutes, 25-35 CNY。



1.Subway routes

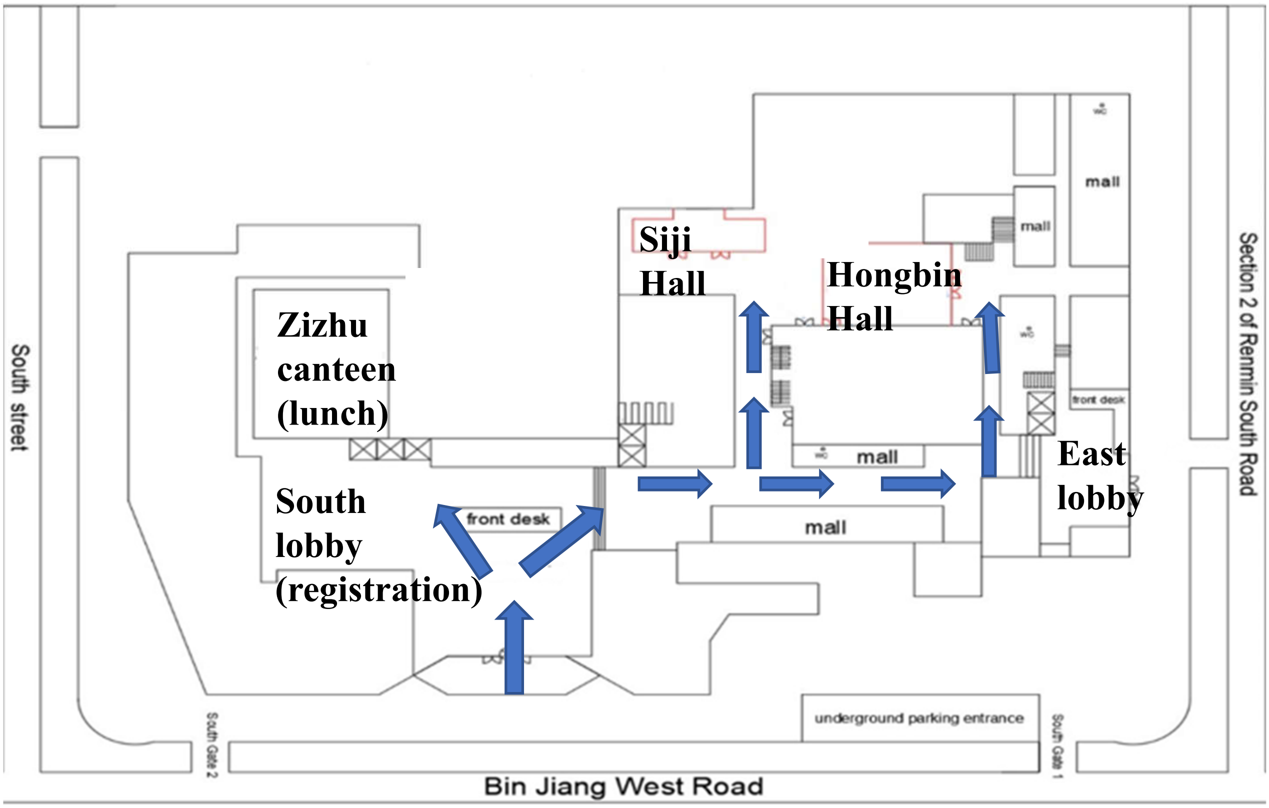


2. TAXI routes

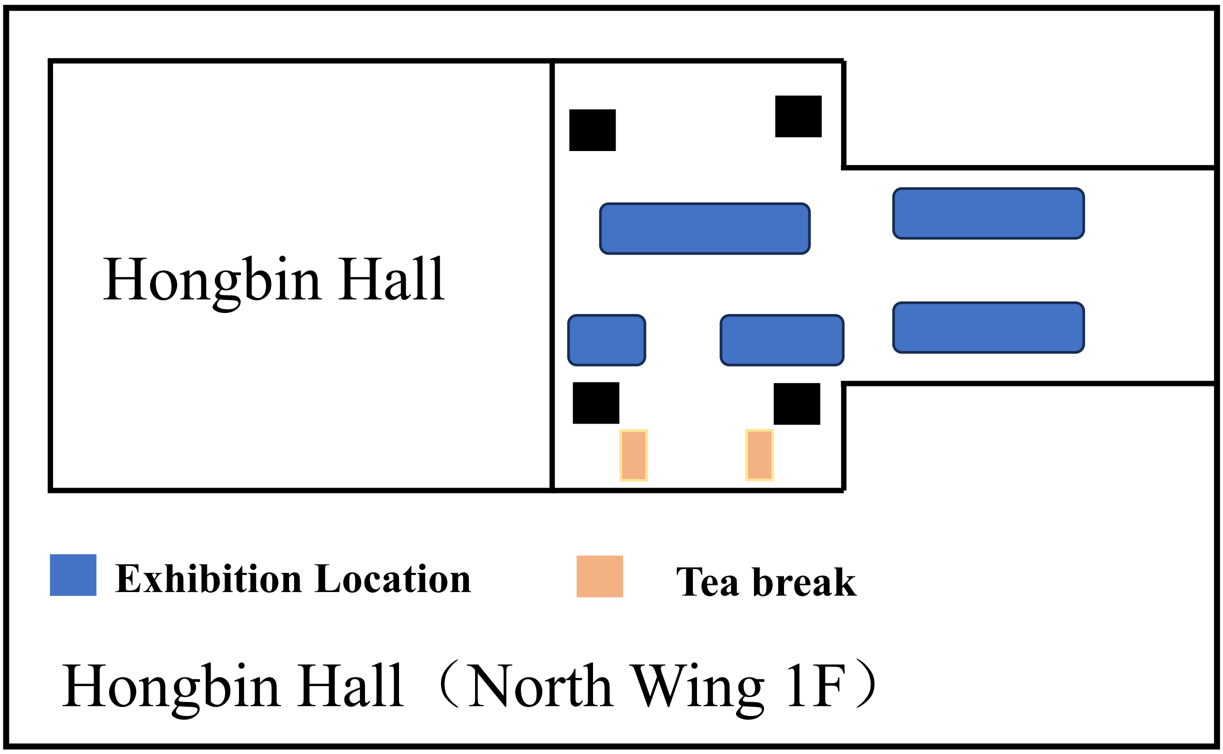
Floor plan of session

Time: September 19 - September 20

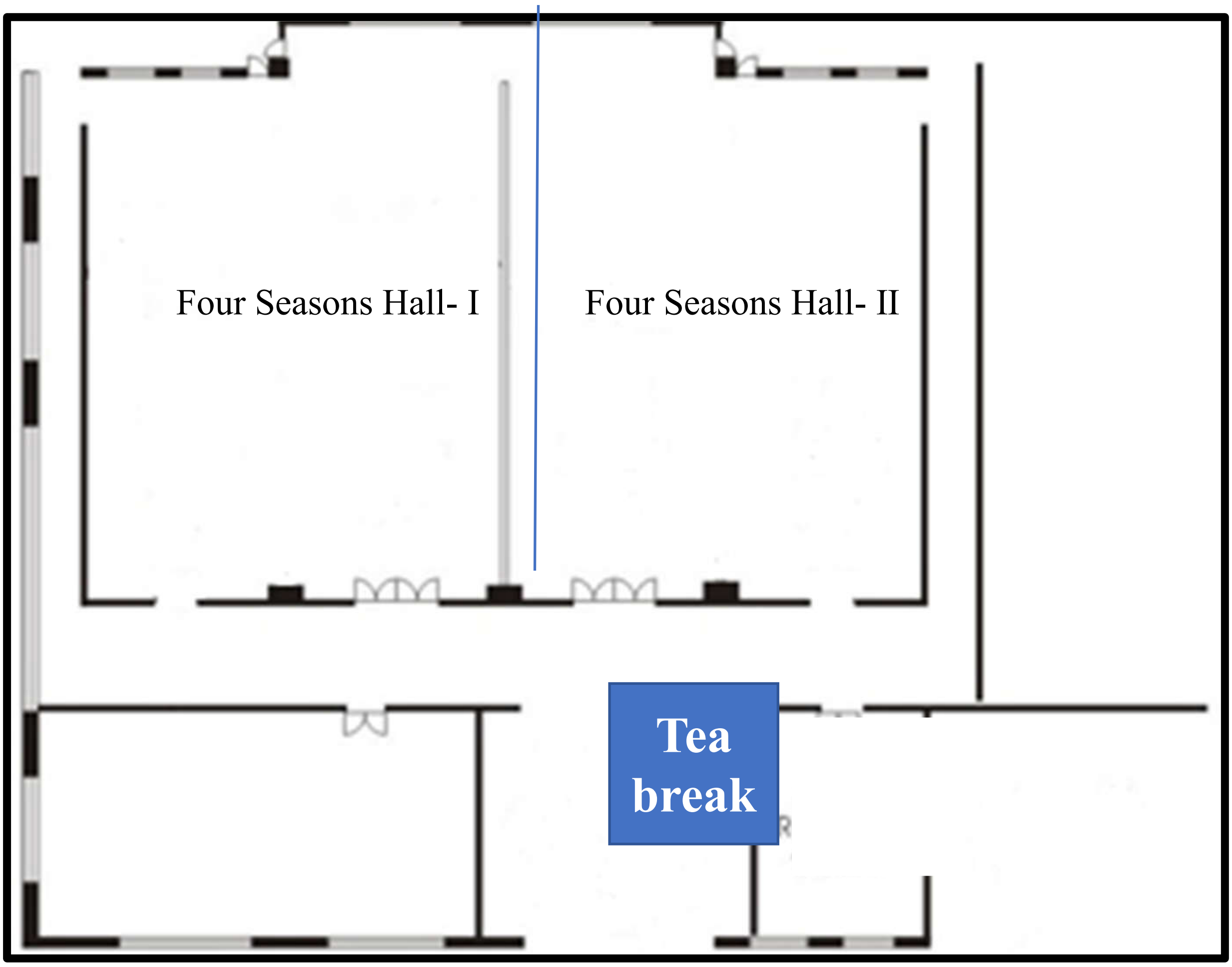
I. Overall floor plan of Jinjiang Hotel



II. Hongbin Hall： Exhibition Hall & Poster Presentation Session（North Wing 1F）



III. Four Seasons Hall： Oral Presentation Session（North Wing 1F）



Session Program

—Program at a Glance—

JCK MEMS/NEMS 2024 Program at a Glance		
18 September(Thursday)		
13:00-22:00	Registration	Jinjiang Hotel
19 September(Friday)		
09:00-17:50	Registration	Jinjiang Hotel
08:30-09:00	Opening ceremony and guest speeches	
09:00-10:30	Plenary lecture 3	
10:30-11:00	Group photo, Tea break	Poster exhibition
11:00-12:00	Invited talk 7	Oral presentation 2
12:00-13:50	Lunch	Poster exhibition
13:50-15:30	Invited talk 19	Oral presentation 8
15:30-16:00	Tea break	Poster selection
16:00-17:30	Invited talk 28	Oral presentation 13
17:30~	Dinner, Special Memorial Talk(prof. Dong F. Wang), and Award ceremony	Jinjiang Hotel
20 September(Saturday)		
09:00-17:30	Registration	Jinjiang Hotel
09:00-10:10	Invited talk 35	Oral presentation 18
10:10-10:25	Tea break	Poster exhibition
10:25-11:20	Invited talk 41	Oral presentation 21
12:00-14:00	Lunch	Poster exhibition
14:00-15:10	Invited talk 45	Oral presentation 29
15:10-15:25	Tea break	Poster exhibition
15:25-17:20	Invited talk 55	Oral presentation 40
17:20~	Dinner	Jinjiang Hotel
21 September(Sunday)		
07:30-12:00	Special Study Tour	Special Study Tour
14:00-17:00	Visiting the laboratory	National Precision Medicine Industry Innovation Center

Introduction to the plenary lecture

THE SOUND OF MUSIC AT THE NANOSCALE – EXPLORING THE NANOSCALE WORLD WITH NEMS RESONATORS BASED ON LOW DIMENSIONAL

Zenghui Wang
University of Electronic Science and Technology of China

Zenghui Wang, Professor and Doctoral Director of University of Electronic Science and Technology (UEST), National Young Talent Program, received his Ph.D. degree from the Department of Physics, University of Washington, Seattle, and conducted research at Cornell University and Case Western Reserve University. He has been engaged in the research of precision measurement of novel micro-nano electromechanical systems for a long time, and has published papers in Science, Nature Physics, Nature Communications, Science Advances, Nano Letters, ACS Nano, etc., and has been invited to give lectures in various national and international conferences. He is a senior member of IEEE, and a senior member of China Micron and Nano Society, and has been invited as a reviewer for various high-level journals (Nature Nanotechnology, Nature Communications, etc.) in his field for a long time.

Report Abstract:
The advent of low-dimensional nanostructures has enabled a plethora of new devices and systems. Among them, nanoelectromechanical systems (NEMS) offers the unique capability of coupling the exquisite material properties found in these atomically-defined nanostructures with their mechanical degree of freedom, opening new opportunities for exploring exotic phenomena at the nanoscale. In particular, as these devices driven into mechanical vibration—just as musical instruments—they become essentially nanoscale guitars, drums, tuning folks, etc. By studying the infinitesimal mechanical vibrations in these nanoscale "music instruments", i.e., listening to the "sound of music" at the nanoscale, researchers can study a number of fundamental physical processes such as absorption, phase transition, anisotropy, and nonlinear processes.

DESIGN OF MEDICAL DEVICES FROM MULTIPLE PERSPECTIVES

Norihisa Miki
Keio University

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 division head of micro-nano science and technology division of Japanese Society for Mechanical Engineers in 2023. He is currently a department head and a chair of international affairs at the Faculty of Science and Technology. He has been dedicating himself to entrepreneurship education based on his own experience of founding a healthcare startup. He is a president of Keio Ice Skating Club.

Report Abstract:
MEMS/NEMS technologies enable innovative medical devices by exploiting the scale effects and the small size. Our group has been studying a variety of medical devices, which include the implantable artificial kidney, EEG headset with micro-manufactured electrodes, and NiTi stents with micro-features. Such medical devices were found to mandate the designs at multiple perspectives; physics, manufacturing, experimental, clinical, commercial, etc. In this presentation, lessons learned in the development of the artificial kidney and the EEG headset will be shared and discussed.

NEW ARTIFICIAL CELL MEMBRANE PLATFORM FOR ELECTROPHYSIOLOGICAL CHARACTERISTICS ANALYSIS OF ION CHANNEL IN MICROFLUIDIC DEVICE

Tae Song Kim
Korea Institute of Science and Technology

Tae Song Kim received his Ph.D. in the Department of Materials Science and Engineering from the Korea Advanced Institute of Science and Technology (KAIST) in 1993. He then joined the Materials research division of the Korea Institute of Science and Technology (KIST) as a senior researcher in 1994. Dr. Kim spent his postdoctoral research associate experience in the Department of Electrical and Computer Engineering of the University of Minnesota in the USA (1998 - 1999). In KIST, he was principal researcher, the Head of the Microsystem Research Center (2000 - 2004). Then, he served as the Head of the Intelligent Microsystem Center, organizing and directing the Korean government research program "21 Century Frontier Intelligent Microsystems Program" from 2004 to 2010. In 2009, he was conference chair of the 13th International Conference on Miniaturized Systems for Chemistry and Life Sciences (MicroTAS) in Jeju, Korea. He served as President of the Korean BioChip Society (2011) and the Micro & Nano Systems Society (2012). He served as a board member of CBMS from 2010~2015 and president of the steering committee of the International Conference of Microchemistry and Microsystems (ISMM) from 2011 ~ 2013. He was a chief delegate of Korea at the World Micromachine Summit from 2015 ~ 2019. He was the Head of Micro Nano Fab Center in KIST from 2015 to 2020.

Report Abstract:
The lipid membrane in cells is a structural key element that separates the inside and outside of a cell and plays a central role in performing a function to maintain life. In order to mimic the cellular systems called artificial cells for an improved understanding of the biological processes related to the origin of life in the cellular level, compartmentalization is essential using an artificial cell membrane. As a standard requirement for the model membrane, the lipid compartment must provide a sealing performance like the original cell membrane and ensure sufficient stability to explore native-like biological processes, especially, in physiological conditions similar to in vivo. This presentation firstly suggests a new method for fabricating 3D free-standing lipid bilayers (3DFLBs) immobilized on the substrate under physiological ionic conditions by applying hydraulic pressure and an electric field simultaneously in a microfluidic channel. Based on the fusion mechanism among controlled membrane swells in patterned microwells in a microfluidic channel, the effect of external hydraulic pressure on promoting fusion in microwells and how to control the shape and size of 3DFLBs by combining the hydraulic pressure and electric field with an improved sealing characteristic will be presented. Mechanical analysis proves how hydraulic pressure induces morphology changes and membrane tension acting on membrane swells in the microwell, resulting in size- or shape-control fabrication of 3DFLBs immobilized on patterned templates that are highly sealed and extremely stable (survival 17~38 days) as a new platform for electrophysiological analysis of ion channel. In addition, an artificial membrane based in vitro system that provides to measure membrane tension and analyze the mechanical properties of Tentonin 3/TMEM150C known to be an Mechanosensitive (MS) ion channel is also presented.

Thematic sessions

Name of session	Conference session	Time			
		19 a.m.	19 p.m.	20 a.m.	20 p.m.
Session 1	Jinjiang Hotel Hongbin Hall	Session 1	Session 1		
Session 2	Jinjiang Hotel Four Seasons Hall 1	Session 2	Session 2		
Session 3	Jinjiang Hotel Four Seasons Hall 2	Session 3	Session 3		
Ssession 4	Jinjiang Hotel Hongbin Hall			Session 4	Session 4
Session 5	Jinjiang Hotel Four Seasons Hall 1			Session 5	Session 5
Session 6	Jinjiang Hotel Four Seasons Hall 2			Session 6	Session 6

Session I

•Topic 1: Micro/Nano Electro-Mechanical Systems (M/NEMS)

This Session will feature the latest research findings on Micro/Nano Electro-Mechanical Systems (M/NEMS) and related materials and device characterization. As a cutting-edge technology, M/NEMS encompasses a wide range of devices and systems from micrometer to nanometer scale, with broad applications in biomedical, sensors, communications, and energy fields. We welcome innovative contributions in the design, manufacturing, optimization, and application of M/NEMS, especially the development of micro-mechanical systems, nano-mechanical systems, and their integration technologies.

•Topic 2: Materials & Device Characterization

Meanwhile, materials and device characterization are critical for understanding and optimizing the performance of M/NEMS. For this topic, we also look forward to receiving research submissions on the development of new materials, performance evaluation, and device characterization. We particularly encourage studies focusing on nanomaterials, thin film technology, surface and interface analysis, and the mechanical, electrical, and thermal performance characterization of micro and nano devices. Through detailed characterization studies, we can further advance M/NEMS technology and explore its potential in various applications.

Schedule of sessions

September 19, 2024 Session 1 Jinjiang Hotel Hongbin Hall

Topic 1：Micro/Nano Electro-Mechanical Systems(M/NEMS)
Topic 2：Materials & Device Characterization
Session chair：Dongfang Wang，Bo Xu

Time	Content	Name	Institution	Title	
9:00-9:30	Plenary lecture	Zenghui Wang	University of Electronic Science and Technology of China	The Sound of Music at the Nanoscale–Exploring the Nanoscale World with NEMS Resonators Based on Low Dimensional	
9:30-10:00	Plenary lecture	Tae Song Kim	Korea Institute of Science and Technology	New Artificial Cell Membrane platform for Electrophysiological Characteristics analysis of Ion Channel in Microfluidic Device	
10:00-10:30	Plenary lecture	Norihisa Miki	Keio University	Design of Medical Devices from Multiple Perspectives	
10:30-11:00	Group photo, Tea break, Poster selection				**Topic 1**
11:00-11:20	Invited talk	Nan Wang	Shanghai University	Piezoelectric MEMS Thin-Film Acoustic-Wave Devices for RF Applications	
11:20-11:40	Invited talk	Jiangkun Sun	National University of Defense Technology	Generation and Evolution of Phononic Frequency Combs via Coherent Energy Transfer between Mechanical Modes	
11:40-12:00	Invited talk	Xiang Zhao	SouthWest Petroleum University	Coupled Thermoelastic Nonlocal Forced Vibration of an Axially Moving Micro/nano-beam	
12:00-13:50	Lunch, Poster selection				
13:50-14:10	Invited talk	Xuqian Zheng	Nanjing University of Posts and Telecommunications	Ultrawide Bandgap Gallium Oxide (β-Ga_2O_3) Nanoelectromechanical Resonators Vibrating at Radio Frequencies	
14:10-14:30	Invited talk	Jiankai Zhu	University of Electronic Science and Technology of China	Introduction of the Investigating Thermal Properties of 2D Non-Layered Material Using a NEMS-based 2-DOF Approach	
14:30-14:50	Oral presentation	Hao Lyu	Sichuan University	Optimized Design and Performance Evaluation of a Flexible Thermoelectric Generator for Low-Thermal Heat Waste Energy Harvesting	
14:50-15:05	Oral presentation	Ziyan Fang	Xi'an Jiaotong University	High-Temperature Performance of Pt Thin-Film Resistive Temperature Sensors on Silicon Carbide Substrates	

Schedule of sessions

<table>
<tr><td colspan="6">September 19, 2024 Session 1 Jinjiang Hotel Hongbin Hall</td></tr>
<tr><td colspan="6">Topic 1：Micro/Nano Electro-Mechanical Systems(M/NEMS)
Topic 2：Materials & Device Characterization
Session chair：Dongfang Wang，Bo Xu</td></tr>
<tr><td>Time</td><td>Content</td><td>Name</td><td>Institution</td><td>Title</td><td></td></tr>
<tr><td>15:05-15:25</td><td>Invited talk</td><td>Yichuan Wu</td><td>University of Electronic Science and Technology of China</td><td>Controllable Microrobot Driven by Solo-actuator</td><td rowspan="7">Topic 2</td></tr>
<tr><td>15:25-15:45</td><td>Invited talk</td><td>Haiwen Li</td><td>Sun Yat-Sen University</td><td>Solid-state Hydrides for Multiple Energy Applications</td></tr>
<tr><td>15:45-16:15</td><td colspan="4">Tea break, Poster selection</td></tr>
<tr><td>16:15-16:35</td><td>Invited talk</td><td>Bo Xu</td><td>University of Electronic Science and Technology of China</td><td>Atomically Thin Nems Frequency Comb with Both Frequency Tunability and Reconfigurability Via Multiple Internal Resonances</td></tr>
<tr><td>16:35-16:50</td><td>Oral presentation</td><td>Hao Sun</td><td>Xi'an Jiaotong University</td><td>N, S Co-doped Graphene/ Waterborne Polyurethane Composites for Absorption Dominated Electromagnetic Interference Shielding</td></tr>
<tr><td>16:50-17:10</td><td>Invited talk</td><td>Yisen Wang</td><td>Lanzhou University</td><td>Intermodal Coupling in Graphene and CNT Nanomechanical Resonators</td></tr>
<tr><td>17:10-17:30</td><td>Invited talk</td><td>Eslam Naeim H. Abubakr</td><td>The University of Electro-Communications</td><td>Advancing Near-Infrared Photodetection and Spectroscopy Through Interlayer Integration</td></tr>
<tr><td>17:30~</td><td colspan="5">Dinner, Special Memorial Talk(prof. Dong F. Wang), and Award ceremony</td></tr>
</table>

Introduction to the invited speaker of the Session 1

INTERMODAL COUPLING IN GRAPHENE AND CNT NANOMECHANICAL RESONATORS

Yisen Wang is a young researcher at the School of Physical Science and Technology, Lanzhou University. He earned his bachelor's degree from China University of Mining and Technology in 2012 and completed his Ph.D. at Lanzhou University in 2018 under the supervision of Prof. Liang Huang. After obtaining his doctorate, Yisen Wang remained at Lanzhou University as a postdoctoral researcher before officially joining the faculty in October 2022. His research focuses on statistical physics and nonlinear dynamics in NEMS. He has been recognized with a Youth Fund from the National Natural Science Foundation of China and a fund from the Gansu Provincial Natural Science Foundation.

Report Abstract:

Intermodal coupling lies in the foundation of the nonlinear dynamical response of the nanomechanical resonators (NMRs). In this talk, I will present the recent progresses of our group about the intermodal coupling in NMRs. For graphene resonators, modes are classified by symmetry. Within each class, the intermodal couplings are all strong, leading to fast energy transfer channel and intraclass thermalization; while between different classes, the negligibly intermodal couplings prevent efficient energy flow. Furthermore, a thermalization frustration phenomenon is unveiled. For CNT resonators, our all-atom MD simulations investigate coupling between orthogonal flexural modes, identifying two distinct coupling regions, with parametric resonance driven by Duffing nonlinearity. These results offer valuable insights into multimodal dynamics in NMRs, with broad potential applications.

SOLID-STATE HYDRIDES FOR MULTIPLE ENERGY APPLICATIONS

Haiwen Li is a Full Professor at the School of Advanced Energy, Sun Yat-sen University, China. He has a diverse academic background, having served as a Postdoctoral Researcher, JSPS Postdoctoral Fellow, and Assistant Professor at the Institute for Materials Research, Tohoku University, Japan, from 2005 to 2011. He was an Associate Professor at the International Research Center for Hydrogen Energy and the International Institute for Carbon-Neutral Energy Research, Kyushu University, Japan, from 2011 to 2020. Subsequently, he held a professorship at the Hefei General Machinery Research Institute, China, from 2020 to 2024. Dr. Li's research primarily concentrates on developing advanced materials and systems for hydrogen storage and energy storage. He also serves as an Associate Editor for Frontiers in Chemistry and is a member of the editorial boards of Energies, Inorganics, and Hydrogen.

Report Abstract:

Solid-state hydrides have been attracting increasing interest due to the high potentiality for multiple energy applications, such as hydrogen storage, ionic conductivity, superconductivity, thermal energy storage, and so on. Among various groups of solid-state hydrides, metal tetrahydroborate $M(BH_4)n$ such as $LiBH_4$, $Mg(BH_4)_2$ and $Ca(BH_4)_2$, with hydrogen gravimetric density higher than 10 mass%, have been extensively investigated in particular for high density hydrogen storage. The dehydrogenation upon heating is always accompanied with the formation of intermediate borates with chemical formula $[B_xH_y]^{n-}$, including $[B_3H_8]^-$, $[B_5H_9]^-$, $[B_{10}H_{10}]^{2-}$, $[B_{11}H_{14}]^-$, and $[B_{12}H_{12}]^{2-}$, etc. The $[BxHy]^{n-}$ anion tends to grow up to larger boranes with elevated temperature and it tends to form stable $[B_{12}H_{12}]^{2-}$ when the dehydrogenation temperature is above 400 °C. While lower borane $[B_3H_8]^-$ was found to facilitate the rehydrogenation, higher borane $[B_{12}H_{12}]^{2-}$ with a stable icosahedral cage structure has been widely regarded as one of the crucial reasons responsible for the degraded re-hydrogenation performance. $M_2(B_{12}H_{12})_n$, on the other hand, favours its potential application as superionic conductor. For instance, we found that the ionic conductivity of a bimetallic dodecaborate $LiNaB_{12}H_{12}$ could reach 0.79 S/cm at 550 K above its order-disorder phase transition. This value is 10 times higher than that of its single counterpart of $Li_2B_{12}H_{12}$ and $Na_2B_{12}H_{12}$ at the same temperature. In the presentation, we will introduce the state-of-the-art progresses of solid-state hydrides for multiple energy applications and will discuss the perspectives and challenges for practical applications as well.

ULTRAWIDE BANDGAP GALLIUM OXIDE (β-Ga_2O_3) NANOELECTROMECHANICAL RESONATORS VIBRATING AT RADIO FREQUENCIES.

Xuqian Zheng is a professor with College of Integrated Circuit Science and Engineering at Nanjing University of Posts and Telecommunications. He received his B.S. degree in Mechanical Engineering and Automation from Nanjing University of Aeronautics and Astronautics, Nanjing, China, and M.Sc. degree and Ph.D. degree in Electrical Engineering from Case Western Reserve University, Cleveland, Ohio, USA. He worked as a postdoctoral researcher in Department of Electrical and Computer Engineering at University of Florida, Florida, USA. His major research area is ultra-wide-bandgap materials for MEMS/NEMS applications. He also works on the development of piezoelectric MEMS/NEMS, fundamental study of 2D material NEMS devices, and piezoelectric energy harvesting from ambient vibrations. Dr. Zheng has published 23 peer-reviewed journal papers and contributed 15 top conference publications. He was the single recipient from Case School of Engineering of the Ruth Barber Moon Award in recognition of his academic promise and leadership at Case Western Reserve University in 2017. He was in the finalists of the Best Student Paper Competition at the 2016 IEEE International Frequency Control Symposium (IFCS 2016) and the Outstanding Paper Award Competition at the 30th IEEE International Conference on Micro Electro Mechanical Systems (MEMS 2017).

Report Abstract:

Beta-gallium oxide (β-Ga_2O_3) has emerged as a frontrunner for next-generation electronics due to its exceptional material properties. Its ultra-wide bandgap (UWBG, Eg = 4.5-4.9 eV) translates to superior capabilities for high-power, high-frequency applications, surpassing limitations of conventional materials. Additionally, β-Ga_2O_3 offers significant advantages in cost-effective bulk crystal synthesis via liquid phase growth with high-quality crystals. Furthermore, β-Ga_2O_3 exhibits promising mechanical properties, characterized by a high Young's modulus (EY = 261 GPa) and fast speed of sound (c = 6,600 m/s), making it suitable for micro/nano mechanical device applications. This unique synergy of properties positions β-Ga_2O_3 at the forefront of novel micro/nano electromechanical systems (M/NEMS).

Here, we delve into our recent advancements in β-Ga_2O_3 resonant NEMS, including the fabrication of high-frequency (4 MHz to 75 MHz) resonators with exceptional quality factors (Q, up to 1700). We showcase the application of these resonators in real-time solar-blind ultraviolet (SBUV) light detection. Typical device illustration is shown in Fig. 1d. Additionally, we explore the potential of β-Ga_2O_3 vibrating channel transistors (VCTs) for achieving electromechanical coupling within the resonators. This study paves the way for on-chip integration of β-Ga_2O_3 resonant NEMS with β-Ga_2O_3 electronic circuits, thereby significantly propelling the advancement of β-Ga_2O_3-based devices in the realms of electronics, optoelectronics, and physical sensing.

CONTROLLABLE MICROROBOT DRIVEN BY SOLO-ACTUATOR

Yichuan Wu received his B.S. degree in mechanical engineering from China Agricultural University in 2013. He received his Ph.D. degree in mechanical engineering from Tsinghua University in 2019. He visited UC Berkeley from 2016-2018. His research interests include sensors and actuators. He published research papers in Science Robotics, Sensors and Actuators A, IEEE MEMS, and IEEE Transducers.

Report Abstract:

Cockroaches are renowned for their ability to swiftly navigate through tight spaces and robustly withstand high impacts due to their well-controlled locomotion and highly flexible exoskeletons. It has been a long-standing challenge to replicate these features in untethered microrobots (here defined as robots ~1g). State-of-the-art microrobots, often utilizing multiple actuators to produce tunable leg strokes for controlled movement, tend to be heavy, large, stiff, and complex, compromising their agility and robustness. Here, a single actuator is used to tune a robot's leg strokes for controllable movements in various directions. The single-actuator driving scheme, device structural architecture, and control techniques of the microrobot are investigated as key guidance for the development of future controllable and resilient miniaturized robots.

GENERATION AND EVOLUTION OF PHONONIC FREQUENCY COMBS VIA COHERENT ENERGY TRANSFER BETWEEN MECHANICAL MODES

Jiangkun Sun received the B.S. degree in mechanical engineering and automation from the Huazhong University of Science and Technology, Wuhan, China, in 2015. He received the M.S. and Ph.D. degrees in mechanical engineering from the National University of Defense Technology, Changsha, China, in 2018 and 2022 respectively. From 2019 to 2020, he was a visiting student with the Department of Engineering, The University of Cambridge, United Kingdom. He is currently a Lecturer at the Microsystem Laboratory, College of Intelligence Science, National University of Defense Technology. His research interest includes the nonlinear dynamics and control electronics of the MEMS sensors, mainly focusing on the vibratory gyroscopes

Report Abstract:

Phononic frequency combs represent an emerging research field as a direct analogue of optical frequency combs in the mechanical domain. Exploring and understanding the conditions for comb generation and evolution with varying driving parameters are essential to enable future practical applications. In this presentation, we present the generation and evolution mechanism of phononic frequency combs in a nonlinear micromechanical resonator from the perspective of coherent energy transfer between two mechanical modes. A phenomenological model for the system under internal resonance is established to accurately predict the evolution of phononic frequency combs. We propose that our findings could inspire researchers to exploit potential applications of this phenomenon in devices.

INTRODUCTION OF THE INVESTIGATING THERMAL PROPERTIES OF 2D NON-LAYERED MATERIAL USING A NEMS-BASED 2-DOF APPROACH

Jiankai Zhu is an assistant researcher and postdoctoral researcher at the Institute of Fundamental and Frontier Sciences, University of Electronic Science and Technology of China (IFFS, UESTC). His research primarily focuses on nanoelectromechanical systems (NEMS) and nanoelectromechanical sensing. So far, he has authored multiple papers as the first author or corresponding author in journals such as National Science Review, Nano Letters, ACS Nano, InfoMat, and international conferences such as IEEE EFTF-IFCS. He has honored with the Outstanding Doctoral Dissertation Award from the Chinese Society of Micro-Nano Technology, and has twice been awarded the Best Research Work at the AVS 67、AVS68.

Report Abstract:

In contrast to 2D layered materials, which are stacked through van der Waals interactions, 2D non-layered materials are unique in that they are formed by chemical bonds in all three dimensions. This is expected to give rise to intriguing properties in thermal conduction, thermal stability, and phonon dissipation. However, due to challenges in applying existing experimental techniques to such nanoscale samples, the thermal properties of 2D layered materials have remained largely uncharacterized, hindering further exploration and device applications using this promising material system.

In this work, we study thermal conduction of β-In_2S_3 (a typical non-layered 2D material) using a resonant NEMS platform with a variable laser heat source. We leverage two degrees of freedom (DOF) in the 2D NEMS platform, laser position and laser power, to simultaneously determine both the thermal conductivity κ of β-In_2S_3 as 3.7 $Wm^{-1}K^{-1}$ and the interfacial thermal conductance GB between β-In_2S_3 and SiO_2 as 6.4 $MWm^{-2}K^{-1}$. For this specific type of non-layered 2D material, such NEMS-based 2-DOF approach is estimated to be 1 million times more responsive and 2000+ times more sensitive than Raman-spectroscopy-based method. Furthermore, we demonstrate that the unusual thermal conductivity translates to an outstanding power-to-frequency responsivity of the β-In_2S_3 resonator, reaching −447 ppm/μW at 532 nm, the best among drumhead NEMS-based bolometers. Our findings provide insights for understanding the thermal properties of 2D β-In_2S_3 and offer opportunities for exploring potential thermal applications for 2D non-layered materials.

THIN NEMS FREQUENCY DMB WITH BOTH FREQUENCY TUNABILITY AND RECONFIGURABILITY: INTERNAL RESONANCES

Bo Xu, Ph.D.received the Ph.D. in electrical science and technology from the University ofElectronic Science and Technology of China. His research interests have focused on the design andapplication research of MEMS/NEMS devices based on two-dimensional materials. He has receivedtwo best paper awards at international conferences. As the corresponding author or co-autho. He has published 10 papers in the following journals such as ACS Nano, Nano Lett., Small., Appl.Phys. Rev.and international conferences such as IEEE MEMS and IEEE NEMS

Report Abstract:

We report a frequency comb via simultaneous internal resonances (1:2& 1:3) in a NEMS resonatorbased on 2D semiconductor MoS. By applying a single-tone excitation with amplitude Vae beyond thethreshold and carefully setting the gate voltage Vg, multiple internal resonances can be realized andequidistant spectral lines around the fundamental mode frequency are observed. The frequency spacingand the number of spectral lines can be tuned by the driving amplitude Vac, and switched between different configurations by the driving frequency fa.The combination of such resonant responses canbe leveraged to realize NEMS frequency combs with high reconfigurability and fine tunability.

COUPLED THERMOELASTIC NONLOCAL FORCED VIBRATION OF AN AXIALLY MOVING MICRO/NANO-BEAM

Xiang Zhao, born in 1982, is an Associate Professor at Southwest Petroleum University, and holds a Doctor of Engineering degree in Southwest Jiaotong University. He has served as a Visiting Professor at the University of Maryland, USA. Currently, he holds the position of Secretary of the General Mechanics Committee of Sichuan Province. He has successfully led two projects funded by the National Natural Science Foundation of China. So far, he has published 48 papers in prestigious academic journals worldwide including 30 SCI papers. Among his publications are two ESI high-citation hot papers featured prominently within their field. Zhao Xiang actively participates in numerous international conferences where he often serves as session chair due to his expertise in the field. His contributions have been acknowledged through awards such as Best Presentation Award in ICANDVC-2021 and Best Paper Award ICANDVC-2023.

Report Abstract:

Since axially moving material systems were introduced in the 1960s, many different axially moving material systems, such as axially moving strings, beams, and plates have been studied for many decades. In recent years, axially moving micro/nano-beams in micro/nano-electro-mechanical systems become popular. Since thermal effects of micro/nano-beams cannot be ignored, coupled thermoelastic vibrations of axially moving micro/nano-beams are important scientific problems. This work analytically investigates coupled thermoelastic forced vibration and the heat transfer process of an axially moving micro/nano-beam. The small-scale effect is considered not only in the vibration equation but also in the heat transfer equation of the micro/nano-beam. Eringen nonlocal elastic- ity theory and the classical Euler-Bernoulli beam model are used to model the vibration equation of the axially moving micro/nano-beam. The Type III Green-Naghdi heat transfer model is used to establish the heat transfer equation of the micro/nano-beam. The vibration and heat transfer equations are coupled to each other. Green functions, Laplace transform, and eigenfunction expansion are key mathematical tools used to solve the cou- pled equations. In the numerical example, by comparing the present solutions with results of some published articles, the correctness of the present solutions is verified. It is found through numerical analyses that the fun- damental natural frequency of an axially moving micro/nano-beam decreases with its axial velocity, small-scale parameter, and height-to-length ratio. Heat rotation phenomena are first found in this study. The heat rotation phenomena discovered show synchronization between the displacement and temperature. The rotation direction of the temperature can be controlled by changing the axial velocity, height-to-length ratio, and heating position.

PIEZOELECTRIC MEMS THIN-FILM ACOUSTIC-WAVE DEVICES FOR RF APPLICATIONS

Nan Wang received his B.Eng. (Hons.) and Ph.D. degrees from the Department of Electrical and Computer Engineering, National University of Singapore (NUS), Singapore, in 2009 and 2013, respectively. From 2013 to 2022, he has been a scientist at the Institute of Microelectronics (IME), A*STAR (Agency for Science, Technology and Research), Singapore, where was a principal investigator and the RF-MEMS team lead in the Sensors, Actuators, and Microsystems (SAM) Program. From 2022, he is a professor at the School of Microelectronics, Shanghai University, Shanghai, China. His research interests include aluminium nitride (AlN) based MEMS devices for sensing, MHz timing, GHz, mmWave and THz communication applications.

Report Abstract:

In the 5G era, the demand for RF frontend filters increases tremendously. One can easily find more than 50 filters in a high-end smartphone. The technology dominating high band application is aluminum nitride (AlN) based bulk acoustic wave (BAW) filter, while the technology dominating low band application is Lithium Tantalite ($LiTaO_3$) or Lithium Niobate ($LiNbO_3$) based surface acoustic wave (SAW) filter. As the frequency of BAW filter is determined by the film stack of the resonators, one chip can only provide filters for one frequency band. Very soon, the cost and area overhead of packaging tens of BAW filters can no longer be ignored. In order to overcome the limitation of BAW technology, researches have proposed to use piezoelectric MEMS (piezoMEMS) resonators named as Lamb wave resonators, contour mode resonators or lateral vibrating mode resonators, whose frequency can be defined by resonator and its electrode lateral dimensions. However, one common drawback of these resonators is that the effective coupling coefficient ($k_2$eff) is not high enough for band filtering application in RF frontend systems.

$k_2$eff of a resonator is the key parameter which measures the achievable fractional bandwidth of the constituting filter. The resonator's configuration, dimension, material stack and process will all have an impact to the $k_2$eff of a resonator. In this paper, the authors will review the efforts in improving the $k_2$eff of piezoMEMS resonators from research community in the past 15 years. The material will be limited to AlN family, which is proven to be manageable for manufacturing. The authors will also try to make recommendations to the effectiveness of various approaches and the path forward.

MEMS DEVICES BASED ON GLASS REFLOW PROCESS AND ITS APPLICATIONS

Minjie Zhu received the Ph.D. degree from the Department of Mechanical Engineering, Tohoku University, Japan, in 2019. He was a Postdoctoral Researcher with the Graduate School of Engineering, Tohoku University, in 2019. He is currently a Senior Engineer with Instrumentation Technology and Economy Institute (ITEI), China. He is also a Guest Professor at the Sichuan University, China. His research focuses on the fields of MEMS/NEMS, micro-instrument, microfabrication and sensors for industrial and biomedical applications.

Report Abstract:

Glass is widely used in optical MEMS devices, microfluids and packaging through glass via (TGV) due to its unique properties including transparency, biological compatibility, insulating property and microfabrication compatibility. However, glass is still too hard to manufacture precisely at micron or nano scales. Many researchers have made effort to develop a variety of glass preparation methods to meet various application needs. Glass reflow, known as one of typical directly micro-structured glass forming methods, has attracted a lot of attention. Usually, the process of glass reflow is taken after silicon-to-glass anodic bonding. This method has also been demonstrated that suitable for large-scale production. Lots of scholars have carried out relevant studies to optimize the parameters of reflow process. A large number of MEMS devices were developed based on glass reflow. Here we introduce a brief review of process of glass reflow and MEMS devices based on this technology.

ADVANCING NEAR-INFRARED PHOTODETECTION AND SPECTROSCOPY THROUGH INTERLAYER INTEGRATION

Eslam Abubakr Specially Appointed assistant professor at The University of Electro-Communications under a cutting-edge project in growth fields, working on MEMS device fabrication promoting the Silicon industry as gas sensors. I graduated from Aswan University in Egypt in 2011, then traveled to Japan, where I got my Ph.D. in Applied Science for Electronics and Materials from Kyushu University, where I spent six years researching carbon-based materials with the Diamond Research Group. I've worked in advanced clean rooms at the National Institute of Advanced Industrial Science and Technology (AIST Kansai), Takeda Super Clean Room/University of Tokyo, and the Global Innovation Center (GIC)/Kyushu University. Our research has led to nearly 20 peer-reviewed publications and has secured scholarships and grants for international collaborations with institutes like Neel (France) and Hasselt University (Belgium). Currently, We are developing infrared gas sensors using plasmon resonance photodetectors.

Report Abstract:

This study demonstrates a Schottky barrier with modified interface properties supported by a plasmonic assist, which captures near-infrared (NIR) light at room temperature. We incorporated an interlayer to alter the transport of charge carriers within the device. In addition, it serves as a diffusion barrier and adhesion promoter to suppress the formation of intermetallic compounds or plasmonic resonance shifts. The interlayer selection aims to lower the junction barrier height further, enhancing absorption of longer wavelengths up to 2200 nm through a single tunable device. Efficient photodetection is achieved at room temperature with nearly an order of magnitude increase in responsivity compared to previous reports. In addition, signal processing through only basic amplifiers enabled us to achieve reconstructive spectroscopy for multiple incident waveforms due to the high selectivity of the output signal, which promotes its applications in gas sensing, including vibrational absorption bands of alkane groups.

Session II

•Topic 1: Micro & Nano Fabrication Including 3D Printing

This Session will feature the latest research findings on micro and nano fabrication, including 3D printing, and the modeling and simulation of manufacturing processes. Micro and nano fabrication is at the heart of advanced technological development, covering a range of fabrication techniques and methods from the micrometer to the nanometer scale, especially the applications of 3D printing technology. We welcome innovative contributions in the development of micro and nano fabrication technologies, process optimization, and novel applications, particularly the advancement of new materials, precision manufacturing, and microstructure design.

•Topic 2: Modeling & Simulation of Manufacturing Process

Meanwhile, modeling and simulation of the manufacturing process are crucial for understanding and optimizing fabrication techniques. For this topic, we also look forward to receiving research submissions on the modeling, simulation, and optimization of manufacturing processes. We particularly encourage studies focusing on process parameter analysis, system simulation, optimization algorithms, and their applications in practical manufacturing. Through in-depth modeling and simulation research, we can further advance micro and nano fabrication technologies and explore their potential in various high-precision manufacturing applications.

Schedule of sessions

September 19, 2024		Session 2	Jinjiang Hotel Four Seasons Hall 1		
Topic 1：Micro & Nano Fabrication Including 3D Printing Topic 2：Modeling & Simulation of Manufacturing Process Session chair：Liang Tian，Chen Wu					
Time	**Content**	**Name**	**Institution**	**Title**	
9:00-9:30	Plenary lecture	Zenghui Wang	University of Electronic Science and Technology of China	The Sound of Music at the Nanoscale–Exploring the Nanoscale World with NEMS Resonators Based on Low Dimensional	
9:30-10:00	Plenary lecture	TaeSong Kim	Korea Institute of Science and Technology	New Artificial Cell Membrane Platform for Electrophysiological Characteristics Analysis of Ion Channel in Microfluidic Device	
10:00-10:30	Plenary lecture	Norihisa Miki	Keio University	Design of Medical Devices from Multiple Perspectives	
10:30-11:00	Group photo, Tea break, Poster selection				
11:00-11:20	Invited talk	Liang Tian	Xi'an Jiaotong University	Application of metal-based conductive composite materials in conductive cables and printed electronics	**Topic 1**
11:20-11:35	Oral presentation	Yuang Wang	Xi'an Jiaotong University	High power high range vibration energy harvester for Smart Grid	
11:35-11:55	Invited talk	Zhijun Zhao	Southwest Jiaotong University	Innovative Fabrication Strategies for 3D Nanostructures: Nanowelding and Nanotransfer Techniques	
12:00-13:50	Lunch, Poster selection				
13:50-14:10	Invited talk	Sang-Seok Lee	Tottori University	RFMEMS Device Fabrication Using 3D Printing Technology	
14:10-14:25	Oral presentation	Jingru Liao	Sichuan University	Freestanding Micro-calorimeter for Bio-thermal Detection with Single Thermocouple Structure	
14:25-14:45	Invited talkt	Xiaosheng Zhang	University of Electronic Science and Technology of China	Multi-functional Sensing Technology Based on MEMS	
14:45-15:00	Oral presentation	Botao Liu	Institute of Semiconductors, Chinese Academy of Sciences	Investigation of the High-vacuum Au/Si Eutectic Wafer Bonding Process for MEMS Resonators	
15:00-15:20	Invited talk	Jian Zhou	Hunan University	New-type Surface Acoustic Wave Devices and Sensing Application	
15:20-15:35	Oral presentation	Yanan Zhang	Sichuan University	Self-healing Shape-memory Polymer Incorporated with Carbon Black for Thermal Controlled Socket	

Schedule of sessions

September 19, 2024		Session 2	Jinjiang Hotel Four Seasons Hall 1		
Topic 1：Micro & Nano Fabrication Including 3D Printing **Topic 2：Modeling & Simulation of Manufacturing Process** **Session chair：Liang Tian，Chen Wu**					
Time	Content	Name	Institution	Title	
15:35-16:00	Tea break, Poster selection				
16:00-16:20	Invited talk	Chang Song	Sichuan Agricultural University	A Preliminary Exploration of the Future Design Paradigm of Art and Science Integration Under Computational Aesthetic Thinking	**Topic 2**
16:20-16:35	Oral presentation	Xingzhuo Hu	The university of Tokyo	Multi-modal Thin-Film-Transistor(TFT) Arrays for Monitoring Cell Cultures	
16:35-16:50	Oral presentation	Mingkang Li	Zhejiang University	Initial Demonstration of a Closed-loop Two-axis MEMS Accelerometer with Quasi-zero Effective Stiffness	
16:50-17:10	Invited talk	Chen Wu	Xi’an Jiaotong University	Multiphysics Simulation and Microscopic Material Calculation Methods in MEMS Sensor Chip Design and Manufacturing	
17:10-17:30	Invited talk	Ce Wang	Sichuan University	Study of Optical-RF Integrated Composite Energy Harvesting System	
17:30~	Dinner, Special Memorial Talk(prof. Dong F. Wang), and Award ceremony				

Introduction to the invited speaker of the Session 2

STUDY OF OPTICAL-RF INTEGRATED COMPOSITE ENERGY HARVESTING SYSTEM

Ce Wang received the Ph.D degree from the electrical engineering at Kyoto University, Kyoto, Japan in 2020. He was in the Research Institute for Sustainable Humanosphere, Kyoto University., Kyoto University from 2020. And then he was an associate professor since 2021 in college of Electronic Information Sichuan University, China. He has been engaged in research on Solar Power Station/Satellite and Microwave Power Transmission system, included rectenna and amplifier design, Ge simiconductor rectifier device, GaN Simiconductor rectifier amplifier device.

Report Abstract:

This study presents an integrated optical/microwave energy harvesting system designed to provide a continuous power supply for electronic skin and ultra-low power micro-electro-mechanical systems (MEMS) medical sensors. The system is capable of harvesting solar and RF energy simultaneously, effectively reducing the reliance on conventional batteries for these devices. With solar cells, the composite antenna system efficiently converts light energy into electrical energy in bright conditions. In low light conditions, the system uses electromagnetic energy conversion technology to provide continuous power. This multimodal power strategy significantly improves the stability, energy efficiency, sustainability and self-sufficiency of the system, while reducing the complexity, size and manufacturing cost of the power system. The development of this system provides an innovative power solution for low-power medical devices with important scientific and clinical applications.

MULTIPHYSICS SIMULATION AND MICROSCOPIC MATERIAL CALCULATION METHODS IN MEMS SENSOR CHIP DESIGN AND MANUFACTURING

Chen Wu, Assistant Professor in School of Mechanical Engineering, Xi'an Jiaotong University. She received Ph.D. degree in Mechanical Engineering in September 2023, from Xi'an Jiaotong University, Xi'an, China. She was a joint cultivation PHD student during Aug. 2022 to Sept. 2023 at Department of Precision Engineering, University of Tokyo, Japan, sponsored by China Scholarship Council(CSC). From Jan. 2024, she joined the team of Professor Zhuangde Jiang in Xi'an Jiaotong University, as a faculty. She is mainly engaged in MEMS sensors technology, including micro/nano design, fabrication, testing and engineering applications, as well as the advanced research on systematic simulation and material computational methods related to sensor development. She has published more than 20 SCI papers in international renowned journals such as Microsystems & Nanoengineering, ACS Applied Materials & Interfaces, Ceramics International and so on, applied for 20 invention patents and 2 software copyright. She was awarded National Postdoctoral Innovation Talent Program in Oct. 2023.

Report Abstract:

Software simulation and computational materials science, combined with the rapid development of computer science and technology, have greatly promoted the progress of scientific research. On the one hand, simulation calculations can assist theoretical research and simulation of the properties and behaviors of materials more realistically in specific applications. It has played a key role in deciphering the deep-level macroscopic physical phenomena under the coupling of complex physical fields, gaining an in-depth and intuitive understanding of important microscopic material phenomena and exploring their dynamic mechanisms. On the other hand, intelligent simulation calculations can guide and design experiments, making scientific research more rigorous and efficient.

This report focuses on the research of silicon carbide (SiC) high temperature pressure sensor and analyzes the key problems in the design and fabrication of SiC piezoresistive pressure sensor chips. By establishing the macro chip simulation model, micro interface model, and femtosecond laser ablation SiC model, the development history and application scope of different simulation software and numerical calculation methods are introduced. In addition, the design and manufacturing process of SiC high-temperature MEMS pressure sensor chips and their application research results are displayed. Finally, the simulation modeling and numerical calculation of SiC pressure sensor are summarized and prospected, providing theoretical references for the research of various novel MEMS devices.

RFMEMS DEVICE FABRICATION USING PRINTING TECHNOLOGY

Sang-Seok Lee received the Ph.D. degree from the Graduate School of Information Sciences, Tohoku University, Japan, in 1998. From Dec. 1998 to Dec. 1999, he was a Postdoctoral Researcher with the Venture Business Laboratory, Tohoku University. From Jan. 2000 to Jan. 2002, he was a Postdoctoral Researcher with the Electronic Instrumentation Laboratory, Delft University of Technology, The Netherlands. From Mar. 2002 to Sep. 2011, he was a Researcher with the Advanced Technology Research and Development Center, Mitsubishi Electric Corporation, Japan. Since moved to Tottori University, Japan, in Oct. 2011, he had been an Endowed Chair Professor and has been a Professor with the Faculty of Engineering. His research interests include MEMS/NEMS, microfluidics, sensor, and semiconductor technology. He is an Associate Editor of IEEE Sensors Journal, and Micro and Nano Systems Letters.

Report Abstract:

3D or inkjet printing technology is wide spreading in device or component production due to its high-cost performance and rapid prototyping or fabrication time. Recently, the 3D printing technology has also been paid attention in RFMEMS device fabrication. In this report, we review RFMEMS devices fabricated with 3D printing technology. We report our RFMEMS devices fabricated using either polymer or metal 3D printers. Moreover, we discuss challenging points of 3D printing technology for RFMEMS device fabrication, and we present our efforts to overcome problems in 3D printed RFMEMS devices. Finally, we introduce Q- and V-band band pass filter researches undergoing for beyond 5G satellite communication and application of inkjet printing to beyond 5G RF device fabrication.

NEW-TYPE SURFACE ACOUSTIC WAVE DEVICES AND SENSING APPLICATION

Jian Zhou obtained his Bachelor degree from Hunan University (China) in 2010, and received his Ph.D. degree in Electronic Science and technology from Zhejiang University (China) in 2015. He is currently a professor from the College of Mechanical and Vehicle Engineering at Hunan University, China. Until now, He has published over 90 SCI/EI papers, and granted more than 20 patents. He awarded the First Prize in Science and Technology of China Communications and Transportation of Association in 2023, the Productivity Promotion Award of China Association of Productivity Promotion Centers in 2022, and the Second Prize of Science and Technology for CRRC in 2021. His current research interests include MEMS sensors, SAW devices, flexible electronics devices, and their advanced applications.

Report Abstract:

Surface acoustic wave (SAW) sensors have been widely used in the sensing of physical parameters such as temperature, pressure, strain, trace detection of chemical warfare agents such as neurotoxic and erosive agents, as well as biosensing fields such as DNA and proteins detection. SAW sensors have their unique advantages of being easy to wireless and passive, as well as their miniaturization, high sensitivity, low cost, and quasi digital output. Traditional SAW devices are mainly based on rigid substrates such as quartz/lithium niobate/silicon, which are difficult to be attached onto the curved surfaces and monitoring on a curved surface; In addition, traditional SAW sensors generally operate at frequencies below 3 GHz, making it difficult to further improve sensitivity based on mass-loading effects. This report will focus on the recent research work on flexible SAW sensors for accurate flexible acoustic wave sensing system, ultra-high frequency SAW sensors for hypersensitive detection and Artificial intelligence enabled SAW sensors.

A PRELIMINARY EXPLORATION OF THE FUTURE DESIGN PARADIGM OF ART AND SCIENCE INTEGRATION UNDER COMPUTATIONAL AESTHETIC THINKING

Chang Song is an associate professor of the School of Arts and Media, Sichuan Agricultural University. He is awarded the talent of Tianfu Emei Plan, overseas high-level study of Sichuan Province, expert of Sichuan Province expert service group, Member and Think Tank expert of Technology and Art Integration Development Promotion Association in Sichuan Province , "Intellectual Engineer" of Huili City Sichuan Province, "Doctor Honorary Villager" of Luhuo County Sichuan Province and outstanding talent for Double support of discipline construction in Sichuan Agricultural University. Commit to the international education of "Arts and Science Integration, Design Future", the research of Arts and Science integration cross design can assist in diversified service design. His recent research focuses on design methodology, green and flexible design, etc. He has published seven SCI research papers and three invention patents, presided over and participated in more than ten scientific research projects. He has won more than ten domestic and foreign famous design competition awards, the second and third prize of the National Multimedia Courseware Competition of the Ministry of Education, and the bronze medal of the Sichuan Provincial Higher Education Teaching Achievement Award. He also participates in editing two textbooks.

Report Abstract:

Under the computational aesthetic thinking, the integration of art and science has greatly promoted the extensive application of virtual reality technology in various fields and played a significant role. In the construction of new disciplines, interdisciplinary research has served as a "catalyst" to promote the integration of industry, academia, and research. The researchers have focused on exploring the ideas and methods of integrating art and science to empower future design research from the perspective of new art and design disciplines, and applied them to future design studies in medical care, agriculture, culture, and other fields. This has facilitated the development of art-science integration in future design in the context of big data. The design projects of the team, such as "cancer treatment, nanomedicine, pork freshness monitoring, and regenerative virtual reality culture," have explored the design thinking and methods of integrating art and science, while also imagining the future development of artificial intelligence and future design. Therefore, the team has been committed to exploring the interdisciplinary integration in the construction of "four new" fields, including system platform construction, intelligent co-creation, experience enhancement, and further exploration of the "man-machine-environment" synergy.

INNOVATIVE FABRICATION STRATEGIES FOR 3D NANOSTRUCTURES: NANOWELDING AND NANOTRANSFER TECHNIQUES

Zhijun Zhao is an Associate Professor at the School of Smart Cities and Transportation, Southwest Jiaotong University, Chengdu, China. He received his Ph.D. in Mechanical Engineering from Pusan National University, South Korea, in 2018. Following his doctoral studies, he conducted postdoctoral research at the Korea Institute of Machinery & Materials. His research focuses on the development of innovative micro-nano fabrication processes and sensor applications. His research has been published in prominent international journals, including ACS Sensors, ACS Nano, Small, ACS Applied Materials & Interfaces, and Nanoscale. To date, he has authored over 50 SCI-indexed papers.

Report Abstract:

This article explores innovative manufacturing strategies for three-dimensional (3D) nanostructures, focusing on the advanced technologies of nanowelding and nanotransfer. As nanotechnology continues to advance, there is a growing need for complex and highly precise 3D nanostructures, which have significant potential applications in areas such as electronics, biomedicine, and energy conversion. Nanowelding allows for strong connections between nanocomponents by precisely controlling thermal, mechanical, or chemical interactions at the nanoscale, providing a solid foundation for building complex nanostructures. On the other hand, nanotransfer technology enables the accurate transfer of delicate nanoscale elements or patterns onto target substrates, further expanding the range of techniques available for creating 3D nanostructures.

APPLICATION OF METAL-BASED CONDUCTIVE COMPOSITE MATERIALS IN CONDUCTIVE CABLES AND PRINTED ELECTRONICS

Liang Tian is a professor and Ph.D. advisor at Xi'an Jiaotong University, recognized as a top-tier young talent (Category A). He graduated with a bachelor's degree in Materials Science and Engineering from Central South University in 2010. He then earned a master's degree in Materials Science and Engineering from Iowa State University in 2011 and another master's degree in Engineering Mechanics from Iowa State University in 2012. He completed his Ph.D. in Materials Science and Engineering at Iowa State University/Ames National Laboratory in 2015. Starting in 2015, he conducted postdoctoral research at the University of Michigan, Ann Arbor, and Purdue University. Since 2020, he has held a full-time position as a Senior High-Performance Computing Engineer in the United States. Liang Tian has published over 20 papers in authoritative journals on metallic materials, such as Acta Materialia and Composites Part A, with an h-index of 17. His research has been positively reported by international authoritative media such as Advanced Science News, the U.S. Department of Energy, and Phys.org. He has independently developed two software programs for computational materials methodology and participated in three research projects funded by the U.S. Department of Energy.

Report Abstract:

High-performance conductive composites are a crucial component in key fields such as renewable energy utilization, high-voltage power transmission, flexible printed electronic devices, and brain-computer interfaces. These materials generally need to meet essential requirements such as high conductivity and excellent mechanical properties. The author has employed a novel centrifugal atomization technique and equipment to produce micron-sized, highly reactive pure calcium metal powder. Using this, a new type of lightweight, high-strength, high-conductivity aluminum-based pure calcium composite material has been developed. Compared to commonly used industrial aluminum-based cable materials, this new material's density is reduced by 28%, strength is increased by 58%, and conductivity is improved by 28%, resulting in a 22% reduction in power transmission loss. This contributes to enhancing the reliability of conductive cable materials and the efficiency of high-voltage power transmission energy utilization. Additionally, the author has developed a new type of metal/two-dimensional material conductive composite ink. After printing, the conductivity of the flexible circuit made with this conductive composite ink can reach about one-third of that of pure metal conductivity. Its electrical conductivity is 20% higher than that of similar conductive silver paste subjected to the same printing and sintering process, and its fatigue cycle life is 55% longer than that of similar conductive silver paste.

MULTI-FUNCTIONAL SENSING TECHNOLOGY BASED ON MEMS

Xiaosheng Zhang is currently a Professor at University of Electronic Science and Technology of China (UESTC). His research field covers MEMS/NEMS. Prof. Zhang has published 3 scientific books (Wiley and Springer), more than 70 peer-reviewed papers and contributed over 30 conference talks (including Plenary talk for IEEE PowerMEMS 2021), and authorized 32 invention patents. In recognition for his research accomplishment, Prof. Zhang won over 20 academic awards, including National Young Talent Plan, Excellent Doctoral Dissertation of Chinese Institute of Electronics, etc. He also served as TPC member and session chair for TRANSDUCERS 2019 and IEEE NEMS 2017-2021. Prof. Zhang currently serves as Associate Editor for IEEE TNANO and Young Star Editor for Nano Research. He also leads over 10 research projects as PI, including National Key Research and Development Program, National Natural Science Foundation of China, etc.

Report Abstract:

Multi-functional sensing technology plays an essential role in the development of IoT and artificial intelligence. As an attractive future vision, researchers always pursue SMART nodes to realize the integration of different sensing functions within a single microsystem, even within a single chip. In this talk, I would like to share the latest research activities and achievements in our lab focusing on this field, including flexible and Si-based devices.

Session III

•Topic 1: Micro/Nano-Actuators & Robotics

This Session will feature the latest research findings on Micro/Nano-Actuators and Robotics and Medical Engineering Technology. Micro/Nano-actuators and robotics are key components of cutting-edge technology, encompassing actuation and control systems from the micrometer to the nanometer scale, with wide applications in precision operations, biomedical fields, and automation. We welcome innovative contributions in the design, manufacturing, optimization, and application of micro/nano-actuators, especially the development of micro-robots, nano-robots, and their integration technologies.

•Topic 2: Medical Engineering Technology

Meanwhile, medical engineering technology is crucial for driving innovation in medical devices and therapeutic methods. For this topic, we also look forward to receiving research submissions on medical engineering technology, focusing on the development of medical devices, biomaterials, diagnostic technologies, therapeutic instruments, and their clinical applications. Through detailed research, we can further advance medical engineering technology and explore its potential in improving healthcare quality and patient care.

Schedule of sessions

September 19, 2024 Session 3 Jinjiang Hotel Four Seasons Hall 2					
Topic 1：Micro/Nano-Actuators & Robotics **Topic 2：Medical Engineering Technology** **Session chair：Gaopeng Xue，Xiaoming Huang**					
Time	Content	Name	Institution	Title	
9:00-9:30	Plenary lecture	Zenghui Wang	University of Electronic Science and Technology of China	The Sound of Music at the Nanoscale–Exploring the Nanoscale World with NEMS Resonators Based on Low Dimensional	
9:30-10:00	Plenary lecture	TaeSong Kim	Korea Institute of Science and Technology	New Artificial Cell Membrane Platform for Electrophysiological Characteristics Analysis of Ion Channel in Microfluidic Device	
10:00-10:30	Plenary lecture	Norihisa Miki	Keio University	Design of Medical Devices from Multiple Perspectives	
10:30-11:00	Group photo, Tea break, Poster selection				
11:00-11:20	Invited talk	Gaopeng Xue	Harbin Institute of Technology	Three-dimensional Microstage for Scanning Force Microscopy	**Topic 1**
11:20-11:35	Oral presentation	Xianwu Xu	Southwest Jiaotong University	Hollow Silicon Nanopillars Fabricated via Metal-assisted Chemical Etching for Enhancing the Performance of Hydrogen Sensors	
11:35-11:55	Invited talk	Qingkun Liu	Shanghai Jiao Tong University	Intelligent and Integrated Microrobots	
12:00-13:50	Lunch, Poster selection				
13:50-14:10	Invited talk	Libo Gao	Xiamen University	Intelligent Medical Micro-Nano Sensing System	
14:10-14:30	Invited talk	Lijia Pan	Nanjing University	Skin-inspired Flexible Sensors	
14:30-14:45	Oral presentation	Dongqin Chen	Shanghai Institute of Microsystem and Information Technology	Consistency Improved Silicon Nanowire Field-Effect Transistor Sensor with Current Calibration Method	**Topic 2**
14:45-15:05	Invited talk	Xiaoming Huang	Sichuan Eye Hospital	Advances in Applications of Microelectromechanical Systems（MEMS）in Ophthalmology	
15:05-15:25	Invited talk	Hongbo Yin	Sichuan University	Introduction of the Tear fluid: A Novel Source of Disease Biomarkers	
15:25-15:40	Oral presentation	Yunjing Jiao	Xi'an Jiaotong University	Flat-top AWG Spectrum Based on Cascaded MMI	

Schedule of sessions

September 19, 2024		**Session 3**	**Jinjiang Hotel Four Seasons Hall 2**		
Topic 1：Micro/Nano-Actuators & Robotics **Topic 2：Medical Engineering Technology** **Session chair：Gaopeng Xue，Xiaoming Huang**					
Time	Content	Name	Institution	Title	
15:40-16:00	Tea break, Poster selection				**Topic 2**
16:00-16:20	Invited talk	Yongchao Yao	Sichuan University	Introduction of the Deep-Layered Elimination of Biofilm By Using Gold Nanorods (AuNRs) with Surface Charge-switchable activities	
16:20-16:40	Invited talk	Zewei Luo	Sichuan University	The Ω-shaped Fiber Optic LSPR for A Circuit of Cytosensor and Photothermal Therapy	
16:40-16:55	Oral presentation	Leinuo Dong	Zhejiang University	Nonlinearity in the Stiffness-tunable MEMS Accelerometer	
16:55-17:15	Invited talk	Weihua Zhuang	Sichuan University	Introduction of the Lipid Droplets Specific Probes for Imaging of Cardiovascular Diseases	
17:15-17:30	Oral presentation	Haiyang Zhao	Sichuan University	A Wideband Vibration Energy Harvester Based on Internal Resonance	
17:30~	Dinner, Special Memorial Talk(prof. Dong F. Wang), and Award ceremony				

Introduction to the invited speaker of the Session 3

THREE-DIMENSIONAL MICROSTAGE FOR SCANNING FORCE MICROSCOPY

Gaopeng Xue received the B.S. degree in 2011 in Mechanical Engineering and Automation from Dalian Jiaotong University, China, and the M.S. degree in 2014 and Dr. Eng. degree in 2017 in Mechanical Systems and Design from Tohoku University, Japan. From 2017 to 2019, he joined Goertek Technology Japan as a researcher and development engineer focusing on optical MEMS for laser beam scanning. From 2019 to 2022, he was a post doctorial researcher at Tsinghua Shenzhen International Graduate School, Tsinghua University, Shenzhen, China. Since 2022, he is an assistant professor at School of Mechanical Engineering and Automation, Harbin Institute of Technology, Shenzhen, China. His research interests include MEMS actuators for 3D scanning applications, optical MEMS for laser beam scanning and measurement, MEMS gas sensor, etc.

Report Abstract:

Scanning force microscopy (SFM) techniques, including magnetic force microscopy, atomic force microscopy (AFM), friction force microscopy, and electrostatic force microscopy, as essential means of characterization, have been widely used in material surface science and biomedicine engineering. Microscanners for SFM require large strokes and low crosstalk in multiple directions. This report presents three types of XYZ-microstages: chip-level-microassembly comb-drive XYZ-microstage, integrated electrostatic and piezoelectric XYZ-microstage, and integrated electrostatic and thermoelectric XYZ-microstage. This study explores how to overcome the out-of-plane stroke-space limitation of conventional monolithic-wafer-based XYZ-microstages, and how to avoid the crosstalk movements resulting from the coupling connection between in-plane and out-of-plane actuation units.

THE Ω-SHAPED FIBER OPTIC LSPR FOR A CIRCUIT OF CYTOSENSOR AND PHOTOTHERMAL THERAPY

Zewei Luo is an associate researcher from the school of mechanical engineering, at Sichuan University. He focuses on advanced fiber optic-based biosensors for the application of disease diagnosis and environmental monitoring. He has published 50 papers in the Journals of Analytical Chemistry, Biosensors and Bioelectronic, Sensors and Actuators B: Chemical, and TrAC Trends in Analytical Chemistry. H-index=22, more than 1000 citations. He was employed as the guest editor of Biosensors and Frontiers in Chemistry.

Report Abstract:

The metastasize of cancer cells is a principal cause of morbidity and mortality in cancer. The integration with cytosensor and photothermal therapy (PTT) suffers from the drawbacks to completely eliminating the cancer cells for one time. A novel sandwich layer of polydopamine/gold nanoparticles/polydopamine (PDA/AuNPs/PDA) was coated around the Ω-shaped fiber optic (Ω-FO) to design a localized surface plasmonic resonance (LSPR)-based aptasensor for performing an original concept of a circuit of cytosensing-photothermal therapy (COCEPT). The short wavelength peak of the sandwich layer with strong resonance exhibited high refractive index sensitivity (RIS). After being modified with a T-shaped aptamer, FOLSPR endowed unique characteristics of time-dependent sensitivity enhancement behavior for sensitive cytosensors with the lowest LOD of 13 cells/mL. Due to the resonance peak of a long wavelength in the sandwich layer covering the near-infrared region, FO-LSPR exhibits a 160-fold and 30-fold higher rate of maximum increased temperature than that of bare and PDA-coated FO, indicating powerful photothermal conversion efficiency. After taking a full account of localized heat field distribution around FO under flow environment, FO-LSPR-enabled aptasensor circularly captured and released cancer cells in COCEPT processes of cytosensing and PTT, respectively. The aptasensor killed 77.6% of cancer cells in the simulated blood circulation system after 5 cycles of COCEPT. The FO-LSPR-enabled aptasensor could improve both the efficiency of captured cancer cells and PTT to effectively kill the cancer cells, showing great potential to be applied to the inhabitation of cancer metastasizing.

ADVANCES IN APPLICATIONS OF MICROELECTROMECHANICAL SYSTEMS (MEMS) IN OPHTHALMOLOGY

Xiaoming Huang, MD/PhD. Associate Senior Doctor of Sichuan Eye Hospital/Postgraduate tutor, Deputy director of Sichuan Aier Eye Institute, Visiting scholar of the Affiliated Hospital of Osaka University, Young member of the Ophthalmic Branch of the Chinese Society of Ultrasonic Medical Engineering, Member of the Asia-Pacific Ophthalmic Plastic Surgery Association((APSOPRS) , Standing member of the Ophthalmic Special Committee of the International Society of Translational Medicine, Standing member of the Ophthalmic Imaging and Intelligent Medical Branch of the Chinese Medical Education Association, Dr. Huang has been working in ophthalmology for more than 10 years, focusing on thyroid eye disease, ophthalmic plastic and lacrimal tract diseases. She has won the bronze medal in the national Oculoplastic and orbital Surgery video competition. She has published more than 20 papers, presided over 5 projects including provincial and ministerial projects, and participated in many projects such as the National Natural Science Foundation.

Report Abstract:

Purpose: The purpose of this presentation was to review recent advances in applications of Microelectromechanical systems（MEMS）in ophthalmology.

Methods: Research articles about MEMS for particular eye diseases and diagnostic technologies were searched through Pubmed, and the most recent advances were reported.

Results: There are few studies on the application of MEMS in ophthalmology, with a total of 15 research reports. Four studies (27%) were applied to glaucoma, including the construction of two 24-hour real-time intraocular pressure monitoring systems and two aqueous humor drainage systems for glaucoma treatment. MEMS was enabled to improve real-time detection of intraocular pressure and accurate drainage to reduce intraocular pressure. Three studies(20%) were about ocular robotic surgery, two of which were about the improvement of surgical forceps, and one was about the surgical robot operating system for retinal injection, which improved the accuracy of operation and achieved a more minimally invasive operation. Two studies (13%)were improvements of Optical Coherence Tomography instruments, one of which described the first handheld, swept source optical coherence tomography (SSOCT) system capable of imaging both the anterior and
posterior segments of the eye in rapid succession. The other one illustrated the high-speed capability of Space-division multiplexing optical coherence tomography (SDM-OCT) in a clinical setting, which is a high-speed imaging technology which takes advantage of the long coherence length of microelectromechanical vertical cavity surface emitting laser (MEMs VCSEL) sources to multiplex multiple images along a single imaging depth. A few other individual studies including Microtechnology and nanotechnology in nerve repair, retinal prosthesis, a 19-Electrode MEMS Piezoelectric Thin-Film Micro-Deformable Mirror for Ophthalmology and a miniaturized wireless micropump for drug delivery.

Conclusions: The pursuit of more accurate, minimally invasive and convenient approaches for the best treatment and diagnosis methods for ocular diseases may be possible only through the development of engineering. MEMS engineering is a common idea; Here, we provide a systematic review of current MEMS applications in the eye. Finally, by combining microelectromechanical and nanoelectromechanical manufacturing system strategies, interesting fabrication and sensor development can be achieved for early detection of eye diseases and, in some cases, treatment.

INTRODUCTION OF THE TEAR FLUID: A NOVEL SOURCE OF DISEASE BIOMARKERS

Hongbo Yin, associate professor, an ophthalmologist in West China Hospital, Sichuan University. She received MD and PhD degree from Sichuan University in 2009. She then completed a Postdoc project in Wilmer Eye Institute, Johns Hopkins University (2014-2015). She is an clinical expert in ocular diseases. She is also interested in research fields, including transitional medicine, bioengineering and medical-industrial integration.

Report Abstract:

Tear fluid, a thin layer covering the ocular surface, can lubricate and protect the eye as well as maintain clear vision. Its dysfunction causes dry eye, a globally popular ocular disease. With extensive exploration of the tear fluid, the roles of proteins, lipids, metabolites, and nucleic acids within the tear film have been revealed to be associated with various diseases, from ocular pathologies to systemic disorders. The simplicity of collecting and evaluating tear fluid makes it a convenient non-invasive diagnostic tool that easily fits into a personalized approach to medicine based on risk assessment. In addition to conventional Schirmer's test strips and microcapillary tubes methods, MEMS provides another optimal strategies for tear sample analysis. Tear fluid is a promising biological material, a promising source for predictive, diagnostic, prognostic, and mechanistic biomarkers.

SKIN-INSPIRED FLEXIBLE SENSORS

Lijia Pan is a full Professor of the School of Electronic Engineering, Nanjing University, China. He received his B.S. degree in department of polymer science and engineering from South China University of Technology, and obtained Ph.D. of polymer physics from University of Science and Technology of China in 2003. He is committed to the research of polymer electronic materials and devices, electronic skin devices, and intelligent perception. More than 200 articles were published in peer reviewed journals including Nature Sustainability, Nature Communications, PNAS, Adv. Mater., Nano lett., ACS Nano, Adv. Funct. Mater., Energy & Environment. Sci.,, Acc. Chem. Res., and IEEE Electron Dev. Lett. which were cited more than 18000 times, with H-factor 54.

Report Abstract:
As an important physical interface for human interaction with the environment, the skin is a natural super sensitive sensor that converts physical signals such as pressure into electrical signals, achieving tactile and tactile functions. It has the characteristics of flexibility, high-density integration, and comprehensive information processing. The report will focus on the high hysteresis and slow response speed of pressure sensors in biomimetic electronic skin devices due to polymer modulus, viscoelasticity, and other factors. We will introduce our research work on improving the performance of flexible pressure sensors through polymer micro nano interface regulation.

INTRODUCTION OF THE LIPID DROPLETS SPECIFIC PROBES FOR IMAGING OF CARDIOVASCULAR DISEASES

Weihua Zhuang received the Ph.D. in Materials Science from Sichuan University, Chengdu, China, in 2020. He is currently working as assistant professor in the Precision Medicine Translational Research Center, West China Hospital, Sichuan University. His current research interests include micro-nano biosensor, fluorescence probes, nanozyme and POCT.

Report Abstract:
Lipid deposition is closely related to cardiovascular diseases (CVDs), such as atherosclerosis and valvular heart disease. Lipid is not only one of the culprits of CVDs, but also an important biomarker for the early diagnosis of CVDs. Unfortunately, there is currently no effective lipid imaging technique in clinical. The development of lipid targeted probes and lipid imaging technology has shown broad clinical application prospect. To this end, we first developed a series of lipid droplets (LDs) targeted probes for fluorescence imaging of cells, animal tissues and human pathological samples. Our results confirmed that lipid were closely related to the occurrence of CVDs, and these probes might be effective tools for studying the pathophysiology of CVDs. Moreover, nano diagnostic systems were further developed to targeted deliver hydrophobic LDs-specific probes to the CVDs lesions, which could efficiently light up the deposited lipid. On this basis, probes with photoacoustic imaging performance were developed and a nano diagnostic system with dual modal imaging was prepared, which can realize the early diagnosis of carotid artery plaques through photoacoustic and fluorescence imaging. These results are expected to provide inspiration for the development of LDs targeted imaging technology for CVDs.

INTELLIGENT MEDICAL MICRO-NANO SENSING SYSTEM

Libo Gao received his Ph.D. from City University of Hong Kong in 2018. Following his graduation, he served as a Research Associate at City University of Hong Kong, an Associate Professor at Xidian University, and an Associate Professor at Xiamen University. He was selected as a "Nanqiang Young Top-notch Talent" by Xiamen University, a high-level talent of Xiamen City, and a participant in Shaanxi Province's "Thousand Talents Program." Dr. Gao has been engaged in the research of micro-nano sensing technology and instruments throughout his doctoral studies and subsequent academic career. He serves as an Academic Editor for the SCI journal *Journal of Sensors* and as a Guest Editor for *Micromachines*, *Electronics*, and *Frontiers in Materials*. Additionally, he is a Youth Editorial Board Member for *Rare Metals* and *NPE*. As the first or corresponding author (including co-authors), Dr. Gao has published over 50 SCI papers in journals such as *Nature Communications*, *Materials Today*, *Microsystems & Nanoengineering*, *Nano-Micro Letters*, *IEEE IoT*, and *IEEE TED*. His work has been cited over 3,900 times (Google Scholar, H-index of 33).

Report Abstract:

In recent years, wearable electronic devices have played a significant role in monitoring human health, preventing diseases, and detecting key physiological indicators. This report will focus on the design and fabrication of wearable integrated electronic devices based on flexible and MEMS sensors, and their applications in the closed-loop monitoring of daily physiological information, such as ECG, heart sounds, and pulse waves. Building on this, an intelligent medical-grade device has been developed to digitally integrate the "Four Diagnostic Methods" of traditional Chinese medicine—inspection, listening and smelling, inquiry, and palpation—by incorporating pulse diagnosis, visual diagnosis, olfactory diagnosis, and inquiry diagnosis. This approach provides a more convenient and accurate means for both home-use portable and professional medical-grade diagnostics.

INTELLIGENT AND INTEGRATED MICROROBOTS

Qingkun Liu, associate professor in the Department of Micro/nano-electronics at Shanghai Jiao Tong University. He received his PhD degree at Zhejiang University, and worked at Cornell University, University of Colorado (Boulder) afterwards. His research focuses on microrobotics, smart materials and nanofabrication. He has published more than 60 papers in high-profile journals, such as Nature, Science Robotics, Science Advances、PNAS、Advanced Materials、Nano Lett.、 Phys. Rev. Lett. etc. with >3000 citations.

Report Abstract:

Sixty years of rapid development of integrated circuits have brought remarkable opportunities for information processing, storage and control. By using micro-fabrication technology to integrate control circuits onto microrobots, they could execute more intelligent tasks. However, it's challenging to fabricate actuators and to integrate the small components for this brand-new type of microrobots. This report will first introduce a new type of electrically controlled nano-actuator, which features low driving voltage, fast speed, and compatibility with semiconductor processes. Using this new type of nano-actuator, we have designed a series of origami-based micro-machines, such as micro-stages, mechanical metamaterials, and potentially the world's smallest origami bird. Using the same nano-actuator, we also fabricated programmable artificial cilia chips to generate arbitrary flow field patterns. Finally, by integrating micro-circuits, micro-energy, and nano-actuators via semiconductor processes, we have achieved wirelessly controlled microrobots. These microrobots will find broad applications in miniature medical surgeries, drug delivery, and environmental monitoring in the future.

INTRODUCTION OF THE DEEP-LAYERED ELIMINATION OF BIOFILM BY USING GOLD NANORODS (AUNRS) WITH SURFACE CHARGE-SWITCHABLE ACTIVITIES

Yongchao Yao completed his PhD in Chemistry in 2019 under the supervision of Prof. Shiyong Zhang at Sichuan University. In 2020, he joined the laboratory of Prof. Zhiyong Qian for post-doctoral research at the same University. Since 2021, he has been an associate researcher at Sichuan University. He has published over 20 papers on international journals including Nat. Synth., Chem, Adv. Mater., Angew. Chem. Int. Ed., Chem. Sci., Chem. Mater., Small, J. Mater. Chem. A/B, Chem. Commun., Acta Biomater., Chem. Eng. J., J. Controlled Release, Asian J. Pharm. Sci., ACS Appl. Mater. Interfaces, Adv. Healthcare Mater., J. Energy Chem. and so on. Now his research activity primarily focuses on the rational design of functional nanostructures toward applications for medical devices, micro/nano biosensors, biochips, and electrochemical high-throughput drug synthesis etc.

Report Abstract:

The escalating prevalence and severity of bacterial biofilm infections, coupled with the emergence of multidrug-resistant bacteria, present significant challenges to public health systems, primarily due to the formidable resistance of these pathogens to conventional antibiotics. The development of novel antibacterial agents capable of effectively inhibiting or eradicating biofilms is therefore of critical importance. In this study, we designed a series of smart gold nanorod (AuNR) systems that exhibit potent antibacterial activity upon near-infrared (NIR) laser irradiation within biofilm microenvironments, while sparing healthy tissues. Firstly, AuNRs were easily synthesized and surface-modified with a polymethacrylate containing pendant carboxyl betaine groups. This modification ensures stability at the pH levels found in blood and normal tissues but prompts rapid aggregation in response to the acidic extracellular pH characteristic of biofilms, thereby enabling effective photothermal therapy under NIR laser irradiation. Secondly, we developed a synergistic chemo-photothermal antimicrobial platform (P(Cip-b-CB)-AuNRs), which features surface charge transformability and lipase-triggered antibiotic release. This platform demonstrated enhanced antibacterial efficacy against methicillin-resistant Staphylococcus aureus (MRSA) in both planktonic and biofilm states. Thirdly, we introduced a novel, variable-sized photothermal platform based on AuNRs, where ciprofloxacin (CIP) was encapsulated within the copolymer shell of the nanocomposites (CIP@P(NIPAM-AA-MAA)-AuNRs). Beyond the pH-induced surface charge transformation, the NIR-stimulated photothermal effect causes the nanocomposites to shrink, enhancing their penetration into biofilms and triggering a rapid and localized release of ciprofloxacin. This results in a synergistic antibacterial effect through the combined action of hyperthermia and chemotherapy. Given these advantages, the AuNPs with surface charge-switchable properties developed in this work show significant potential as effective antibacterial agents for applications in healthcare and environmental engineering.

Session IV

•Topic 1: Micro/Nano-Chemical & Physical Sensors

This Session will feature the latest research findings on Micro/Nano-Chemical and Physical Sensors and Micro/Nano-Bio Devices and Systems. Micro/nano sensor technology is a vital area of modern science and technology, encompassing chemical and physical sensors from the micrometer to the nanometer scale, with broad applications in environmental monitoring, industrial control, and biomedical fields. We welcome innovative contributions in the design, manufacturing, optimization, and application of micro/nano sensors, especially the development of highly sensitive, selective, and stable sensor technologies.

•Topic 2: Micro/Nano-Bio Devices & Systems

Meanwhile, micro/nano-bio devices and systems are crucial for advancing biomedical research and applications. For this topic, we also look forward to receiving research submissions on micro/nano-bio devices and systems, focusing on biosensors, biochips, microfluidics, nano drug delivery systems, and their applications in diagnostics, therapy, and bio-detection. Through detailed research, we can further advance micro/nano-biotechnology and explore its potential in healthcare and life sciences.

Schedule of sessions

September 20, 2024		Session 4	Jinjiang Hotel Hongbin Hall		
Topic 1：Micro/Nano-Chemical & Physical Sensors **Topic 2：Micro/Nano-Bio Devices & Systems** **Session chair：Teng Ma，Yi Zhang**					
Time	Content	Name	Institution	Title	
09:00-09:20	Invited talk	Hao Jia	Shanghai Institute of Microsystem and Information Technology	High-Performance MEMS Thermopiles for Differential Thermal Analysis	**Topic 1**
09:20-09:35	Oral presentation	Jiang Zhu	Dalian University of Technology	Low-damage Laser Lift-off of Submicron-thick AlGaN/GaN HEMT Film	
09:35-09:55	Invited talk	Cheng Tu	University of Electronic Science and Technology of China	High-performance Resonant Sensing Based on AlN-on-Si Structure	
09:55-10:10	Oral presentation	Heqiu Zhang	Dalian University of Technology	The Investigation of GaN High Electronic Mobility Transistor Sensors	
10:10-10:25	Tea break, Poster exhibition				
10:25-10:45	Invited talk	Xuhui Sun	Soochow University	Artificial Olfaction Platform Based on MEMS Gas Sensor Array	
10:45-11:00	Oral presentation	Yuxiang Qiu	The university of Tokyo	Remote Vital Sign Monitoring of Multiple Moving Targets Using a Single FMCW Radar for Daily In-Home Healthcare	
11:00-11:20	Invited talk	Hemin Zhang	Northwestern Polytechnical University	Coherent Energy Transfer in Coupled Nonlinear Micromechanical Resonators	
12:00-14:00	Lunch, Poster exhibition				
14:00-14:20	Invited talk	Teng Ma	Beijing Institute of Technology	Modelling and Integration of Gas Sensors Based on Semiconducting Materials	
14:20-14:35	Oral presentation	Zhongbin Zhang	Soochow University	A Multi-parameter Wireless MEMS Sensing System with High Flexibility and Integration for Servo Mechanisms	
14:35-14:50	Oral presentation	Jiajia Xiang	Sichuan University	High Sensitivity Two-dimensional Nano-electromechanical Pressure Sensor Based on Frequency Combs	**Topic 2**
14:50-15:05	Oral presentation	Yilin Wang	University of Electronic Science and Technology of China	Wearable Multi-functional Sensor for Health Monitoring	

Schedule of sessions

September 20, 2024		Session 4	Jinjiang Hotel Hongbin Hall		
Topic 1：Micro/Nano-Chemical & Physical Sensors **Topic 2：Micro/Nano-Bio Devices & Systems** **Session chair：Teng Ma，Yi Zhang**					
Time	Content	Name	Institution	Title	
15:05-15:20	Tea break, Poster exhibition				**Topic 2**
15:20-15:40	Invited talk	Yi Zhang	University of Electronic Science and Technology of China	Intelligent Magnetic Soft Millirobots Fabricated by 3D Printing for In Vitro Diagnostics	
15:40-15:55	Oral presentation	Ohga Nomura	Keio University	Sampling Moiré Method Triaxial Force Plate Using Metal 3D Printed Structure	
15:55-16:15	Invited talk	Joo-Yun Jung	Korea Institute of Machinery and Materials	Biomolecule Detection Based on Infrared Metamaterial Absorber with Vertical Nanogap	
16:15-16:30	Oral presentation	Zenghui Hao	Sichuan University	Failure Analysis and Optimization of MEMS Gas Sensor Based on Reliability Enhancement Test	
16:30-16:50	Invited talk	Ming Lyu	Inner Mongolia University	Research on the Design Method of Mode Localization Sensor Based on Nonlinear Electrostatic Coupling	
16:50-17:10	Invited talk	Jingzhi Wu	North University of China	Terahertz Plasmonic Sensors with Single Molecular Sensitivity	
17:10-17:25	Oral presentation	Jianguo Hu	University of Electronic Science and Technology of China	Low-frequency MEMS Vibration Energy Harvester Based on Piezoelectric Cantilever Beam	
17:30~	Dinner				

Introduction to the invited speaker of the Session 4

COHERENT ENERGY TRANSFER IN COUPLED NONLINEAR MICROMECHANICAL RESONATORS

Hemin Zhang received the B.E. degree in electrical engineering and the Ph.D. degree in microelectromechanical systems and nanotechnology from the Northwestern Polytechnical University, Xi'an, China, in 2011 and 2017, respectively, where he is now a professor. He has ever been a postdoc at ESIEE Paris, University of Cambridge, Cambridge and KU Leuven between 2019 and 2022. His research interests include microelectromechanical systems (MEMS) resonators, coupled resonators, mode-localized sensors and their conditioning circuitry. Prof. Zhang was a recipient of the Outstanding Paper Award Finalist at Transducers 2015, the Outstanding Paper Award Winner at IEEE MEMS 2016, the Silver Award of the Chinese Mechanical Engineering Society (CMES) Hiwin Doctoral Dissertation Award in 2018, and Marie Skłodowska-Curie (MSCA) Individual Fellowship in 2019.

Report Abstract:

Energy decay, describing the leakage of system energy to the environmental bath, is a universal behavior in oscillators. It has been utilized to elucidate the energy transfer between vibrational modes of a single resonator. Under specific conditions, it is possible to generate a stronger direct energy interaction between a resonator and its coupled companion compared to interactions with the environmental bath. In this talk, the ringdown processes of two nonlinearly coupled micromechanical resonators with an ultra-low coupling rate of 9.6 Hz are both measured and theoretically analyzed. This ultra-low coupling rate leads to significantly observable energy redistribution and distinctive periodic transient coherent energy transfer, especially when the coupled microelectromechanical resonators are modulated by Duffing nonlinearity and asymmetry in system parameters. Time-resolved eigenstates represented by amplitude ratio responses are provided as a tool to quantitatively uncover the internal energy transfer between the nonlinearly coupled resonators.

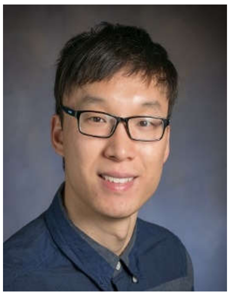
HIGH-PERFORMANCE MEMS THERMOPILES FOR DIFFERENTIAL THERMAL ANALYSIS

Hao Jia, Associate Professor at Shanghai Institute of Microsystem and Information Technology (SIMIT). He received his Ph.D. degree in Electrical Engineering, Case Western Reserve University, USA. His research focuses on micro/nanoelectromechanical systems (MEMS/NEMS) sensors and chip-scale analytical instruments. He has published more than 60 peer-reviewed papers. He was the recipient of the Shanghai Leading Talent Award and Pujiang Talent Award. He was also the recipient of "Young Scientist Award Finalist", "Scientific Innovation Award", "Best Oral Presentation Award", "Best Paper Award" at international conferences, including IEEE MEMS, and Transducers.

Report Abstract:

Differential thermal analysis (DTA) stands as a pivotal thermal analysis technique in the realm of material characterization, with its significance spanning diverse fields like energy, environmental protection, and the petrochemical industry. However, traditional bulky and expensive DTA instruments have faced the bottleneck of low sensitivity (~1-10 mV/W) and slow heating and cooling rates (~1°C/s), thereby impeding the accuracy and efficiency in innovating functional nanomaterials. To address this challenge, we have developed a chip-scale DTA technique by using MEMS technology. Through high-density integration of heaters and thermocouples on a single microchip, the DTA sensors exhibit ultra-high sensitivity (~30mV/°C, 100V/W) and ultra-fast heating and cooling rates (~105°C/s), both representing significant improvements over the traditional DTA counterparts. Our high-performance MEMS sensors hold promise for next-generation rapid and precise DTA characterization for a wide range of applications.

HIGH-PERFORMANCE RESONANT SENSING BASED ON ALN-ON-SI STRUCTURE



Cheng Tu is currently a Research Associate at University of Electronic Science and Technology of China. He received the B.S. and M.S. degrees both from University of Electronic Science and Technology of China, and Ph.D. degree from City University of Hong Kong. Afterwards he worked as postdoctoral research associate in University of Illinois at Urbana-Champaign and Northeastern University successively. His research interests cover from design to simulation to fabrication and electrical characterization of MEMS resonators for applications of resonant sensors and RF acoustic filters.

Report Abstract:

This presentation will briefly show the efforts of our research group in developing different resonant sensors utilizing Thin-film Piezoelectric-on-Silicon (TPoS) micromechanical resonators. TPoS resonators offers strong electromechanical coupling using piezoelectric transduction and exhibit high quality factor due to the low damping acoustic cavity usually made of single crystal silicon. In addition, when AlN is adopted as piezoelectric layer, the fabrication process of the resonator is CMOS-compatible, which makes AlN-on-Si resonators highly attractive from the view of potential monolithic integration with CMOS circuitry. In this talk, I will show the demonstration of applying AlN-on-Si resonators for sensing acceleration, magnetic field strength and temperature on a single chip, which proves TPoS resonators as a viable technique in realizing high-performance resonant sensing.

ARTIFICIAL OLFACTION PLATFORM BASED ON MEMS GAS SENSOR ARRAY

Xuhui Sun received his B. Sc. and M. Sc. degrees in chemistry from Tsinghua University, Beijing, and Ph.D. degree in material science from the City University of Hong Kong. Before joined Institute of Nano Functional & Soft Materials (FUNSOM), Soochow University in 2009 as a professor, he was a research scientist at NASA Ames Research Center and adjunct assistant professor at Santa Clara University, CA. His research interests are focused in the area of the nanomaterials and their applications in nanoelectronics, sensors and energy harvesting. He has published over 280 papers in high impact journals such as J. Am. Chem. Soc., Angew. Chem. Int. Ed., Adv. Mater., Nat. Commun., ACS Nano, Chem. Rev., etc. and held 5 US patents and 60 Chinese patents. He is a senior member of IEEE and has served associate editor of IEEE Transaction on Nanotechnology and editor board member of Frontiers in Materials and Nanomaterials. He has been PI or co-PI of a number of projects from the nation key research program, the national high-tech R&D Program and National Science Foundation of China (NSFC). He founded Suzhou Huiwen Nanotechnology Co., Ltd. in 2014, serving as the Chairman and Chief Scientist. The company focuses on the research, development, and production of advanced smart sensors.

Report Abstract:

As the core component of artificial olfaction (also named e-nose), gas sensors can detect the types and concentrations of gases in the environment, which have been applied in various areas such as environmental monitoring, public safety, healthcare, food safety, etc. With the development of MEMS and artificial intelligence (AI) technology, artificial olfaction constructed using MEMS gas sensor arrays (analogous to olfactory receptors in biological olfaction) and AI algorithms (analogous to the olfactory nervous system in biological olfaction) plays an important role in more fields, achieving the development path of gas sensors from "functional implementation" to "performance improvement" to "intelligent recognition." This talk will introduce the development of MEMS gas sensor technology and the development and application of artificial olfaction platforms based on gas sensor arrays.

MODELLING AND INTEGRATION OF GAS SENSORS BASED ON SEMICONDUCTING MATERIALS

Teng Ma, Professor of Beijing Institute of Technology and Visiting Professor of Tohoku University, graduated from Tsinghua University (Bachelor degree), Xidian University (Master degree) and Tohoku University (PhD degree). He then worked as a postdoc and as an Assistant Professor at Tohoku University. At 2023, he joined Beijing Institute of Technology. His main research interests include gas sensors, biosensors, photosensors, and advanced nano-micro fabrication techniques.

Report Abstract:
As one of the important sensors of modern intelligent systems, gas sensors hold extremely broad application prospects. Among the various existing gas sensor technologies, metal oxide semiconductor (MOS) gas sensors stand out due to their low cost, easy integration, high sensitivity, and rapid response speed, attracting significant attention from both industry and academia. Nevertheless, there is a lack of guiding principles and policies related to gas sensor design. To address this, we have constructed a multi-physics model for MOS gas sensors based on gas dynamics and semiconductor electronics, and systematically investigated the influence of various parameters on the performance of gas sensors. Based on the results, we have also provided guiding principles to be followed in designing high-performance gas sensors. An integratable gas sensor design was also proposed.

RESEARCH ON THE DESIGN METHOD OF MODE LOCALIZATION SENSOR BASED ON NONLINEAR ELECTROSTATIC COUPLING

Ming Lyu, 2022 graduated from Dalian University of Technology. His main research interests are sensor design based on microelectromechanical systems: including micro-nano sensors and actuators, mems dynamics, and micro-nano mechanical resonators.

Report Abstract:
At present, the research of modal localization sensor mainly adopts linear approximation model, which is difficult to accurately explain the nonlinear vibration behavior under large amplitude excitation. Therefore, we systematically studies the nonlinear vibration behavior and control methods of electrostatic coupling resonators under different excitations, and deeply explores the influence of structural geometry and voltage control parameters on the primary resonance, superharmonic mode localization phenomena. The design method of electrostatic coupling mode localization micro-mass sensor and acceleration sensor considering the influence of multi-source nonlinearity is proposed, and the realization method of high-performance sensor to suppress and control the influence of process error is given. The MEMS electrostatic coupling resonator and acceleration sensor sample are developed and the experimental research is carried out.

INTELLIGENT MAGNETIC SOFT MILLIROBOTS FABRICATED BY 3D PRINTING FOR IN VITRO DIAGNOSTICS

Yi Zhang is currently a Professor at the University of Electronic Science and Technology of China. Previously he served as an assistant professor at the School of Mechanical and Aerospace Engineering at Nanyang Technological University, Singapore. He was also an affiliated faculty of China Singapore Joint International Research Institute, Singapore Center for 3D Printing, NTU-HP Digital Manufacturing Corp Lab, and Nanyang Quantum Science and Engineering Center. He received his Ph.D in Biomedical Engineering from Johns Hopkins University School of Medicine, USA, in 2013 and B.Eng in Bioengineering from Nanyang Technological University, Singapore, in 2007. He received his postdoc training in the Institute of Bioengineering and Nanotechnology, the Agency of Science Technology and Research (A*STAR), Singapore from 2013−2015, and subsequently worked there as a Research Scientist from 2015−2016. His research aims to develop micro and nano systems to bridge the gap between engineering advancement and current medicine practice. His achievement is recognized by a series of awards including Nanyang Young Alumni Award, Outstanding Self-Financed Student Overseas, Hodson Fellowship, Siebel Scholar, and various Young Scientist Awards, Best Conference Awards and Art in Science Awards.

Report Abstract:

3D printing via vat photopolymerization (VP) is a highly promising approach for fabricating magnetic soft millirobots (MSMRs) with accurate miniature 3D structures; however, magnetic filler materials added to resin either strongly interfere with the photon energy source or sediment too fast, resulting in the nonuniformity of the filler distribution or failed prints, which limits the application of VP. To this end, a circulating vat photopolymerization (CVP) platform that can print MSMRs with high uniformity, high particle loading and strong magnetic response is presented in this study. After extensive characterization of materials and 3D printed parts, it is found that $SrFe_{12}O_{19}$ is an ideal magnetic filler for CVP and can be printed with 30% particle loading and high uniformity. By using CVP, various tethered and untethered MSMRs are 3D printed monolithically and demonstrate the capability of reversible 3D-to-3D transformation and liquid droplet manipulation in 3D, an important task for in vitro diagnostics that have not been shown with conventional MSMRs. An AI-enabled and fully automated liquid droplet handling platform that manipulates droplets with MSMR is presented for detecting carbapenem antibiotic resistance in hazardous biosamples as a proof of concept, and the results agree with the benchmark.

Session V

•Topic 1: Micro & Nano Electronics Including Flexible Electronics

This Session will feature the latest research findings on Micro & Nano Electronics, including Flexible Electronics, and Micro/Nano-enabled Wearable Devices. Micro/nano electronics technology is at the core of modern electronics advancement, covering various electronic devices and systems from the micrometer to the nanometer scale, with a special emphasis on flexible electronics applications. We welcome innovative contributions in the design, manufacturing, optimization, and application of micro/nano electronic devices, especially the development of high-performance, low-power, and flexible electronic devices.

•Topic 2: Micro/Nano-enabled Wearable Devices

Meanwhile, micro/nano-enabled wearable devices are crucial for driving the development of next-generation smart devices. For this topic, we also look forward to receiving research submissions on micro/nano-enabled wearable devices, focusing on health monitoring, activity tracking, environmental sensing, and their applications in personal health management and human-computer interaction. Through detailed research, we can further advance micro/nano wearable technology and explore its potential in enhancing quality of life and smart applications.

Schedule of sessions

September 20, 2024 Session 5 Jinjiang Hotel Four Seasons Hall 1					
Topic 1：Micro & Nano Electronics Including Flexible Electronics **Topic 2：Micro/Nano-enabled Wearable Devices** **Session chair：Weiqing Yang，Zhuoqing Yang**					
Time	Content	Name	Institution	Title	
09:00-09:20	Invited talk	Kai Tao	Northwestern Polytechnical University	Micro Vibration Energy Harvesting and Self-powered Sensing	**Topic 1**
09:20-09:35	Oral presentation	Yibo Ma	Kyushu University	Development of Molecular Transfection into Cells via Electromechanical Poration	
09:35-09:55	Invited talk	Shanshan Jia	Sichuan Agricultural University	Laminar-Structured Bulk Wood Based Materials for Tough Environments Affordable and High Sensitive Sensing Application	
09:55-10:15	Invited talk	Wenjing Jie	Sichuan Normal University	Optoelectronic Synaptic Devices Based on 2D Layered Materials	
10:15-10:30	Tea break, Poster exhibition				
10:30-10:50	Invited talk	Xiaodong Wu	Sichuan University	Bio-Inspired Sensing Principles for Novel Artificial Electronic Skins	
10:50-11:05	Oral presentation	Yura Takeuchi	Kumamoto University	Evaluation of Myoblasts' Response to Compression Stimuli Using a Microfluidic Device	
11:05-11:25	Invited talk	Weiqing Yang	Southwest Jiaotong University	Supercritical Etching of MXene and Its Multifunctional Integration&Applications of Energy-Information All-in-one micro-Devices	
12:00-14:00	Lunch, Poster exhibition				
14:00-14:20	Invited talk	Liang He	Sichuan University	Integrated System Based on Micro Energy Storage Device	
14:20-14:35	Oral presentation	Zengyi Wang	Harbin Institute of Technology, (Shenzhen)	MEMS XYZ-microstage with Uncoupled Motions by Integrating In-plane Electrostatic Actuation with Out-of-plane PZT Actuation	
14:35-14:55	Invited talk	Yonggang Jiang	Beihang University	Highly Sensitive Calorimetric Sensors for Flow Analysis and Human Motion Tracking	**Topic 2**
14:55-15:10	Oral presentation	Jiaqi Wu	University of Electronic Science and Technology of China	Achieving 1.2 fm/Hz1/2 Displacement Sensitivity with Laser Interferometry in Two-Dimensional Nanomechanical Resonators	

Schedule of sessions

<table>
<tr><td colspan="6">September 20, 2024 Session 5 Jinjiang Hotel Four Seasons Hall 1</td></tr>
<tr><td colspan="6">Topic 1：Micro & Nano Electronics Including Flexible Electronics
Topic 2：Micro/Nano-enabled Wearable Devices
Session chair：Weiqing Yang，Zhuoqing Yang</td></tr>
<tr><td>Time</td><td>Content</td><td>Name</td><td>Institution</td><td>Title</td><td></td></tr>
<tr><td>15:10-15:25</td><td colspan="4">Tea break, Poster exhibition</td><td rowspan="8">Topic 2</td></tr>
<tr><td>15:25-15:45</td><td>Invited talk</td><td>Zhuoqing Yang</td><td>Shanghai Jiao Tong University</td><td>Fabrication and Applications of MEMS Devices on Ultra-Thin Cylindrical Substrate Surface</td></tr>
<tr><td>15:45-16:00</td><td>Oral presentation</td><td>Xun An</td><td>Sichuan University</td><td>Enzyme Immobilization in Completely Packaged Microfluidic for Calorimetric Biosensor with Microfabrication Technology</td></tr>
<tr><td>16:00-16:20</td><td>Invited talk</td><td>Xudong Fang</td><td>Xi’an Jiaotong University</td><td>Flexible Pressure Sensors and Strain Sensors for Potential Applications in Wearable Devices</td></tr>
<tr><td>16:20-16:35</td><td>Oral presentation</td><td>Kunyuan Guo</td><td>University of Electronic Science and Technology of China</td><td>Investigation of using Heavy Metal for Spurious Modes Suppression in Laterally-excited Bulk Acoustic Wave Resonators</td></tr>
<tr><td>16:35-16:55</td><td>Invited talk</td><td>Tingting Yang</td><td>Southwest Jiaotong University</td><td>Moisture-electric Generators Based on Bionic Nanoionics</td></tr>
<tr><td>16:55-17:10</td><td>Oral presentation</td><td>Zechun Li</td><td>Shanghai Institute of Microsystem and Information Technology</td><td>High-Sensitive Hydrogen Sensor in Oxygen-Free Environment with MEMS Differential Thermopiles</td></tr>
<tr><td>17:10-17:25</td><td>Oral presentation</td><td>Hao Zheng</td><td>University of Electronic Science and Technology of China</td><td>Micro-nano Energy-sensing Integrated Flapping Wings for Bionic Flying Robots</td></tr>
<tr><td>17:30~</td><td colspan="5">Dinner</td></tr>
</table>

Introduction to the invited speaker of the Session 5

BIO-INSPIRED SENSING PRINCIPLES FOR NOVEL ARTIFICIAL ELECTRONIC SKINS

Xiaodong Wu is a tenure-tracked Associate Professor in the Department of Mechanical Engineering (ME) at Sichuan University. He obtained his bachelor's degree and doctor's degree from Sichuan University in Jun. 2014 and Dec. 2019. From Oct. 2017 to Jun. 2021, he worked as a Research Scholar in the Department of Electrical Engineering and Computer Sciences (EECS) at University of California, Berkeley. His research interests and fields focus on 1) flexible electronic materials, 2) flexible sensing technologies, 3) artificial electronic skin, 4) wearable healthcare and human-machine interfacing, and 5) bioinspired or biomimetic devices and systems. So far, he has published over 50 SCI papers in academic journals, including Science Advances, Advanced Materials, Advanced Functional Materials, Research, Nano Energy, etc., with more than 3500 citations (Google Scholar) and H-Index of 26. He served as the reviewers for many academic journals, such as Science Advances, Advanced Materials, Advanced Functional Materials, Nano Energy, Advanced Science, and so on. He also served as the youth Editorial Board members for the journal of Advanced Bionics.

Report Abstract:

Artificial electronic skins that mimic the sensory functionalities of the natural skin are critical and highly desirable for the emerging fields of prosthetics and robotics. Complex sensing devices/systems have been explored to construct artificial electronic skins. However, the sophisticated fabrication, complex operation, and high power-consumption pose challenges for their practical and widespread applications. Motivated by the limitations of the currently existing electronic skins, we successfully developed a number of novel potentiometric sensing mechanisms and created a whole set of innovative sensors for constructing electronic skins with distinctive characteristics. Furthermore, we demonstrated that diverse environmental stimuli in our daily life (e.g. temperature variation, static and/or dynamic pressure, mechanical vibration, etc.) can be detected and recorded in real time with our electronic skins. These highly effective and energy-efficient electronic skins provide a much-improved human-machine interfacing medium and open up great opportunities for creating a new range of humanoid robotics, skin prosthetics, wearable healthcare devices, bioelectronics, and autonomous smart systems.

MICRO VIBRATION ENERGY HARVESTING AND SELF-POWERED SENSING

Kai Tao is a faculty member in the School of Mechanical Engineering at Northwestern Polytechnical University. He holds a B.Eng. and M.Eng. in Microelectronics from Central South University and Shanghai Jiao Tong University, respectively. He earned his Ph.D. from Nanyang Technological University in 2016. From December 2015 to February 2017, he was a postdoctoral research fellow with the Singapore-MIT Alliance for Research and Technology project. Since February 2017, he has been leading a research team in the Department of Microsystem Engineering at Northwestern Polytechnical University. His research interests revolve around the fabrication of NEMS/MEMS, energy harvesting and self-powered MEMS devices. He has published over 100 papers and has been cited over 6000 times with an H-index of 45, according to Google Scholar. Seventeen of his papers have been recognized as highly cited papers. He was selected for the National Youth Talent Program and listed in the World's Top 2% Scientists by Stanford (top 0.5% in 2023). He also serves as an editor for several international journals and a general/session chair for IEEE INEC, IEEE/ASME AIM, and VEH (2021-2023) international conferences.

Report Abstract:

Recent advancements in technology have led to the development of micro-scale energy harvesting technologies, which have the potential to enable self-autonomous devices and intelligent monitoring activities. However, these technologies still face challenges such as narrow bandwidth and low output performance. The report aims to address two key questions: "How can we expand and improve the working frequency of energy harvesting devices?" and "How can we use micro/nano processing technology to enhance output efficiency?". It introduces the mechanism characteristics, manufacturing methods, and device applications, including multi-mode nonlinear frequency expansion theory and helical gear clutch frequency up mechanism, etch-free micro-charge graphic preparation method, and research on the application of micro/nano energy harvesting devices in human-machine interaction interfaces and self-powered wireless health monitoring. This may lay the technical foundation for overcoming the practical limitations of micro/nano energy harvesting devices.

FABRICATION AND APPLICATIONS OF MEMS DEVICES ON ULTRA-THIN CYLINDRICAL SUBSTRATE SURFACE

Zhuoqing Yang has been a Professor at Shanghai Jiao Tong University (SJTU) since 2018 and is a resident member of National Key Laboratory of Advanced Micro and Nano Manufacture Technology at SJTU since 2010. He received PhD in 2010 from SJTU. His research interests include the design, simulation, and fabrication of micro electromechanical system (MEMS) and flexible devices. He was invited as a TPC Member and the Section Chair for several international conferences, such as IEEE International Nanoelectronics Conference (INEC) in 2018 and IEEE NEMS in 2019, and has given keynote/oral presentations. Prof. Yang is also an IEEE senior member.

Report Abstract:

With the development of the Internet of Things (IoT), wearable devices and implantable biomedical components, the flexible sensors, actuators and electrical circuits have been demanded more and more widely. Microelectromechanical systems (MEMS) devices based on 3D micro-fabrication technologies have attracted a great deal of attention due to their small size, lower costs, large volume production and low consumption. This speech will focus on a new 3D microfabrication technology based on the ultra-thin cylindrical substrate surface. It's our developed a novel micromachining method that mainly includes spray coating, lithography pattering and multi-layer alignment on the flexible cylindrical substrate, such as optical fiber, polymer tube, capillary and other tubes. It can realize the integrated fabrication of many sensors and actuators with different functional materials on an ultra-thin (hundreds of micrometers) flexible or stiff cylindrical substrates, which is very promising to various ultra-thin MEMS sensors, especially for those optical devices, wearable respiratory monitoring devices and biomedical applications in the future.

LAMINAR-STRUCTURED BULK WOOD BASED MATERIALS FOR TOUGH ENVIRONMENTS AFFORDABLE AND HIGH SENSITIVE SENSING APPLICATION

Shanshan Jia is currently a Distinguished Professor, and PhD supervisor in College of Forestry, Sichuan Agricultural University, China. She received the Ph.D. degree in College of Materials Science and Engineering, Central South University of Forestry and Technology, Changsha, China, in 2020. During this time, she studied in Chemical Department, UCL, London, UK, for 1 year. Her research is mostly focused on efficient use of wood resources. In particular, She is interested in Engineering materials. She has received and participated more than 10 national and provincial projects in the area of superhydrophobic wood fabrication and utilization and super strong wood as construction materials. She has published more than 10 papers with total impact factor close to 100, as first author and corresponding author. She is a reviewer for many authoritative journals such as Applied Surface Science, Polymers, Journal of Colloid and Interface Science, and Chemical Engineering Journal.

Report Abstract:

High temperature affordable flexible polymer based pressure sensors integrated with repeatable early fire warning service are highly desired for harsh environmental applications, yet remains challenging. This work proposed an approach to prepare such advance integrated sensors based on silver nanoparticles (Ag NPs) and ammonium polyphosphate (APP) modified laminar-structured bulk wood sponge (APP/Ag@WS). Such integrated sensors demonstrated excellent fire warning performance, including short response time (minimum to 0.44 s), long lasting alarm time (> 750 s), reliable repeatability. Moreover, it achieved high temperature affordable flexible pressure sensing that exhibited almost unimpaired working range of 0-7.5 kPa and a higher sensitivity (at low pressure range, maximum to 226.03 kPa^{-1}) after fire. The high stability was attributed to reliable structural elasticity, and the wood derived amorphous carbon contributes repeatable fire warnings. Finally, Ag@APP/WS based wireless fire alarm system that realized reliable house fire accident detection was demonstra ted, showing great promise for smart firefighting application.

HIGHLY SENSITIVE CALORIMETRIC SENSORS FOR FLOW ANALYSIS AND HUMAN MOTION TRACKING

Yonggang Jiang is currently a professor with the School of Mechanical Engineering and Automation, Beihang University. His research interests include nano/micro manufacturing, bionic sensing, and bionic intelligent Microsystems (MEMS). He is a co-inventor on more than 30 patents and has published more than 80 papers in peer-reviewed journals such as Nat. Commun., Sci. Adv., Microsyst. Nanoengin. etc. He developed polyimide-based flow and pressure sensor array for flight parameter estimation and SiC-based high-temperature pressure and temperature sensors. .His research has been recognized by several awards, including Mechanical Industry Science and Technology Award (Second Prize in 2022), Beijing Novel program (2014).

Report Abstract:

This report presents the design, fabrication and evaluation of a highly sensitive flexible calorimetric flow sensor. By employing vanadium dioxide as the temperature sensing material with a high temperature coefficient of resistance, the proposed sensor achieves a high flow velocity resolution of 0.11 $mm \cdot s^{-1}$ and a fast response time of 16ms. Due to its high sensitivity and fast response, the relative airflow velocity caused by variations in human limb posture during movement can be estimated. Overall, the proposed sensor has many promising applications in weak airflow detection and human motion tracking.

MOISTURE-ELECTRIC GENERATORS BASED ON BIONIC NANOIONICS

Tingting Yang is an associate professor at the School of Mechanical Engineering, Southwest Jiaotong University. She received her Ph.D. in Materials Science and Engineering from Tsinghua University in 2017. She has presided two national and provincial scientific research projects, and one "Science and Technology Star" project of Southwest Jiaotong University. She has participated in another five scientific research projects, including national key research and development projects. Dr. Yang has published 30 SCI papers as the first author or the corresponding author, including Nature Communications, Materials Science & Engineering R-Reports, Advanced Energy Materials, ACS Nano, Advanced Functional Materials, Biosensors and Bioelectronics, Sensors and Actuators B, ACS Sensors, Advanced Science, Nano Energy, Materials Horizons, Nano Research, etc. Four of them were selected as ESI highly cited papers, with the highest number of citations for a single paper being 901 times, and the total number of citations of published papers exceeding 5,000 times, with an h-index of 25. Dr. Yang has published one monograph and authorized eight invention patents.

Report Abstract:

Bionic nanofluidics is inspired by the generation and storage mechanism of neural signals in the brain. Through micro-nano manufacturing technology, nano-confined structures are designed to achieve intelligent regulation of the transmission behavior of ions and other fluids. Artificial nanofluid devices have broad application prospects in interdisciplinary fields such as brain-like intelligence, brain-computer interface and micro-nano energy. Focusing on the basic scientific problem of "the mapping relationship between atomic and molecular properties, micro-nano structural properties, and macroscopic device performance", the speaker accurately designed micro-nanoscale structures at the atomic/molecular level to achieve fine regulation of water and ion transmission behaviors and develop high-performance energy harvesting devices in humid environments. In order to break through the power bottleneck of existing moisture-electric generators (MEGs), a variety of nano-confined structures (PN junctions, hierarchical porous and electrode interface layer designs) were innovatively proposed to achieve efficient and directional transport of moisture-induced ions, so that the device power density reaches 100 μW/cm2. In order to break through the life bottleneck of existing MEGs, an ion migration recovery strategy through multi-source energy coupling stimulation was proposed to effectively improve the durability of ion migration, thereby achieving the purpose of simultaneously improving the power output and life of the device. In order to promote the practical application of MEGs, the cross-scale large-area manufacturing technology of MEGs compatible with printing processes was developed. It achieved customized mW-level power output, and demonstrated its feasibility for powering wireless sensor nodes. In addition, we developed a proximity sensor based on moisture-electric technology, which has the advantages of high sensitivity, suitable for close-range object detection, fast response, self-power, and biospecificity. Its application prospects include health management, early warning systems, contactless switches to prevent virus transmission, object recognition, finger trajectory detection and other different scenarios.

INTEGRATED SYSTEM BASED ON MICRO ENERGY STORAGE DEVICE

Liang He, PhD, Professor, BoD, Independent Group Leader (PI), Sichuan University "Double Hundred B" Talents, Sichuan Province "Specially Appointed Experts", was awarded the Second Prize of National Natural Science in 2019 (ranked 4th). During his work in the State Key Laboratory of New Material Composite Technology of Wuhan University of Science and Technology, he has been selected as one of the "Chutian Scholars" program in Hubei Province, the "Chenguang Young Scientific and Technological Talents" program in Wuhan City, and the "Young Top Talents" program in Wuhan University of Science and Technology. During his tenure, he has been selected for the "Chutian Scholars" program in Hubei Province, the "Chenguang Young Scientific and Technological Talents" program in Wuhan and the "Young Top Talents" program in Wuhan University of Technology.

Report Abstract:
Designing and constructing multifunctional integrated devices based on stacked microelectrodes, such as flexible micro-capacitance humidity sensors and flexible micro-capacitance strain sensors, are highly important in integrated systems. Due to their unique interconnecting structures, the performance regulation of stacked microelectrodes has great potential. For example, by using composite microelectrodes with high special areal capacity and micro/nano structures with high electrical conductivity to construct the alternating stacked layers, effective improvements in energy density, power density, rate performance, and reliability can be achieved. This type of stacked microelectrode and micro/nano manufacturing process has unique advantages in performance improvement, and large-scale manufacturing for the integration of micro/nano functional units in integrated systems.

FLEXIBLE PRESSURE SENSORS AND STRAIN SENSORS FOR POTENTIAL APPLICATIONS IN WEARABLE DEVICES

Xudong Fang, is an associate professor at school of mechanical engineering, Xi'an Jiaotong University (XJTU). He received BSc and MSc in mechanical engineering from XJTU, and Ph.D. in materials science and engineering from Georgia Institute of Technology, USA. After graduation, he started to work in XJTU since November 2016. His research areas include micro/nano fabrication and MEMS sensors, polymeric fibers and composites, and flexible sensors and electronics. He has held and participated in more than 15 research projects including National Key R&D Program of China, and NSF of China etc. Since 2010, he has published more than 60 academic papers and applied over 60 patents of China and USA. He serves as the associate editor of International Journal of Nanomanufacturing, the discipline secretary of the journal Engineering, the vice director of Shaanxi Province Micro Mechanical and Electronic Systems (MEMS) Research Center and the director assistant of the International Joint Laboratory for Micro/Nano Manufacturing Measurement Technologies.

Report Abstract:
The multi-functional flexible tactile sensor has garnered significant attention due to its promising applications in health monitoring, flexible touch screens, flexible electronic skin, and soft robotics. Currently, a crucial factor limiting the application of these sensors is the coupling of output signals and crosstalk. In this study, we employ a sensor system with distinct electrical output signals. Specifically, the thermo-resistive temperature sensors and capacitive pressure sensors are designed separately, focusing on different structural and material systems, and both are integrated into multifunctional flexible tactile sensors. This design allows for resistive detection of temperature signals and capacitive detection of pressure signals. The developed multifunctional flexible tactile sensor can detect pressure within a range of up to 50 MPa, achieving a maximum sensitivity of 3.838×10^{-2} kPa^{-1} in the pressure range of 0-40 kPa. When the thermal resistance is used to detect temperature, the sensor has a temperature detection range of 30-150 °C, with a resistance temperature coefficient of 2.68×10^{-3} ppm/°C, demonstrating high linearity at 0.998. This sensor not only enables simultaneous monitoring of pressure and temperature but also mitigates signal coupling, allowing for the concurrent assessment of an individual's motion and health states. This approach addresses the limitations of single-function flexible tactile sensors and the signal coupling challenges faced by multi-functional flexible tactile sensors, providing new insights for future research in this domain.

SUPERCRITICAL ETCHING OF MXENE AND ITS MULTIFUNCTIONAL INTEGRATION & APPLICATIONS OF ENERGY-INFORMATION ALL-IN-ONE MICRO-DEVICES

Weiqing Yang, Dean of the Institute for Advanced Research in Frontier Science at Southwest Jiaotong University, is a professor and doctoral supervisor at the School of Materials Science and Engineering. His research primarily focuses on the fundamental applications of nanomaterials for energy and functional devices. In recent years, he has published over 260 SCI-indexed papers in international journals such as Nature, Adv. Mater., ACS Nano, and Nano Lett., with 25 highly cited papers according to ESI, accumulating over 16,000 citations. He has been recognized as a highly cited researcher by Clarivate Analytics for multiple consecutive years. Yang has led numerous provincial and ministerial-level projects including those funded by the National Natural Science Foundation, the Ministry of Education's Innovation Team, JWKJW Key Projects, and Sichuan Province Innovation Teams. He serves as an expert reviewer for the Ministry of Science and Technology's major R&D programs and the National Science and Technology Awards. Additionally, he has applied for over 40 patents (24 granted) and has facilitated the commercialization of more than 20 patents, with direct transfer funds exceeding 30 million RMB

Report Abstract:

In the context of space-constrained special environments, the real-time monitoring and fault diagnosis of critical systems such as high-speed train bogies, strategic military equipment, and key components of aerospace engines are crucial for ensuring the safety and reliability of intelligent systems. One significant global technological challenge lies in supplying micro-energy for multi-parameter monitoring of critical components operating in space-constrained special environments. In recent years, intelligent micro-sensing technologies, represented by miniaturized multifunctional integrated devices, have rapidly advanced, promising to address this critical technological challenge. Compared to traditional single-function, large-volume monitoring devices, miniaturized multifunctional integrated devices exhibit characteristics of miniaturization, intelligence, and multifunctionality. They offer advantages such as multi-parameter monitoring and wide applicability, potentially enabling real-time health monitoring in confined spaces.

This report proposes a new strategy of "one material, multiple capabilities, and process compatibility" for fully integrated multifunctional MXene energy-information devices. Using CO_2 supercritical exfoliation technology, over 10 types of MXene have been successfully etched and prepared within 5 hours, achieving kilogram-level etching of Ti_3AlC_2 in a single step. Furthermore, utilizing high-energy supercritical CO_2 as a physical catalyst and subcritical H_2O as a chemical catalyst, Nb_4C_3Tx has been etched and prepared within 1 hour, producing kilogram-level "one material, multiple capabilities" MXene with capabilities including energy harvesting, energy storage, pressure sensing, and optoelectronic detection.The development of "process-compatible" MXene inks with rheological control techniques, utilizing techniques such as electrorheological 3D inkjet printing and laser engraving, integrates into self-powered wireless microsensors. This achieves long-term reliable applications of MXene-based energy-information multifunctional integrated devices in intelligent sensing fields within space-constrained special equipment, providing scientific and technological support for the strategic requirement of long-term real-time health monitoring.

Session VI

•Topic 1: Networked Microsystems & IoT Technologies

This Session will feature the latest research findings on Networked Microsystems & IoT Technologies and Integration & Packaging Technologies. Networked microsystems and IoT technologies are crucial for advancing smart and interconnected developments, covering sensing, communication, and control systems from the micrometer to the nanometer scale. We welcome innovative contributions in networked microsystems, IoT architecture, protocols, and applications, especially the development of efficient, low-power, and reliable IoT technologies.

•Topic 2: Integration & Packaging Technologies

Meanwhile, integration and packaging technologies are essential for practical implementation of microsystems and IoT devices. For this topic, we also look forward to receiving research submissions on integration and packaging technologies, focusing on microelectronic packaging, system integration, thermal management, reliability testing, and their real-world applications. Through detailed research, we can further advance integration and packaging technologies and explore their potential in enhancing device performance and durability.

Schedule of sessions

September 20, 2024 Session 6 Jinjiang Hotel Four Seasons Hall 2					
Topic 1：Networked Microsystems & IoT Technologies **Topic 2：Integration & Packaging Technologies** **Session chair：Lu Wang，Munehisa Takeda**					
Time	Content	Name	Institution	Title	
09:00-09:20	Invited talk	Lu Wang	Xi'an Jiaotong University	Piezoelectric Vibration Energy Harvesting Powered Wireless Sensors	**Topic 1**
09:20-09:35	Oral presentation	Yue Wang	Southeast University	Simulation of DMD-based Maskless Vector Lithography Model	
09:35-09:55	Invited talk	Tao Wu	Shanghai Tech University	Aluminum Scandium Nitride Thin Film Transducers	
09:55-10:10	Oral presentation	Hao Liu	The University of Tokyo	Flexible Stretch-free, Liquid-sealed Packaging Method for Ultra-thin Silicon-based Bending Sensor	
10:05-10:20	Tea break, Poster exhibition				
10:20-10:35	Oral presentation	Yangzhi Yu	Sichuan University	Programmable Shape Memory Resin Based on Patterned Dopamine Coating Using Photolithography Technology	
10:35-10:55	Invited talk	Peng Li	Huazhong University of Science and Technology	Introduction of the High-Performance Flexible 2D Material Nano Devices for High-Temperature Applications	
10:55-11:15	Invited talk	Dingcheng Zhang	Sichuan University	Railway Wayside Acoustic Detection Using Microphone Array	
12:00-14:00	Lunch, poster exhibition				
14:00-14:15	Oral presentation	Noriko Tsuruoka	Tohoku University	Skin Microperfusion Needle Fabricated Using Non-planar Microfabrication Technique	
14:15-14:30	Oral presentation	Tianxiang Liang	Sichuan University	Multifunctional Thermal Biosensor Based on Silicon Thermocouple Junction and Suspended Microfluidic Channel	
14:30-14:45	Oral presentation	Naonori Etani	Tottori University	Hemodynamic Monitoring Using Fiber-optic Pressure Sensor for Fish	

Schedule of sessions

September 20, 2024 Session 6 Jinjiang Hotel Four Seasons Hall 2

Topic 1: Networked Microsystems & IoT Technologies
Topic 2: Integration & Packaging Technologies
Session chair: Lu Wang, Munehisa Takeda

Time	Content	Name	Institution	Title	
14:45-15:05	Invited talk	Munehisa Takeda	Toyama Prefectural University	The Development of Chip-scale Atomic Clock using Quantum Interference Effect	**Topic 2**
15:05-15:20	Tea break, Poster exhibition				
15:20-15:40	Invited talk	Yibing Li	Southwest Jiaotong University	Electrodeposition of Catalytic Functional Nanomaterials	
15:40-15:55	Oral presentation	Zhitong Zhang	Peking University	FlexConnect: A Flexible, Electromechanically Stable and Universal Bonding Interface for Soft Neural Electrodes	
15:55-16:10	Oral presentation	Luming Wang	University of Electronic Science and Technology of China	Modulating Resonance Mode Sequencing in Nanomechanical Resonators	
16:10-16:30	Invited talk	Yupeng He	Sichuan University	Introduction of the Study on the High-precision Machining of Mold and Glass Molding of Micro-nano Structures	
16:30-16:45	Oral presentation	Honglin Qian	Harbin Institute of Technology (Shenzhen)	Glass-based Micro-Hotplate with Low Power Consumption and TGV Structure Through Anodic Bonding and Glass Thermal Reflow	
16:45-17:05	Invited talk	Xi Zhang	Shenzhen University	Nano-fabrication of Carbon-based Flexible Sensor	
17:05-17:20	Invited talk	Minjie Zhu	Instrumentation Technology and Economy Institute	MEMS Devices Based on Glass Reflow Process and Its Applications	
17:30~	Dinner				

Introduction to the invited speaker of the Session 6

PIEZOELECTRIC VIBRATION ENERGY HARVESTING POWERED WIRELESS SENSORS

Lu Wang , Assistant Professor at the School of Instrument Science and Technology, Xi'an Jiaotong University. His main research direction is piezoelectric device and energy harvesting technology for self powered wireless sensors. He is committed to theoretical analysis, device design and manufacturing of vibration and electromagnetic field energy harvesting. Research on the application of power management and self powered wireless sensing systems. He presided over seven projects, including the National Natural Science Youth Fund, the sub project of the National Key Research and Development Program, the project of the Boxing Innovation Program, the horizontal project of the State Grid, the project of the State Key Laboratory, and the Youth Fund of Shaanxi Province. Published 28 SCI and EI papers in internationally renowned journals such as Nano Energy, Applied Energy, ACS Applied Energy Material, IEEE TIM, and Sensors and Actors A-Physical, including 16 first author or corresponding SCI papers (1 highly cited ESI paper), applied for 19 invention patents (7 authorized), participated in 14 international conferences, gave 10 oral presentations. He was awarded National Postdoctoral Innovation Talent Program, the Shaanxi Province Excellent Doctoral Dissertation and the 2023 MINI Outstanding Young Scientist Award.

Report Abstract:

Sustainable micro power supply is urgent needed, with the booming development of the Internet of Things and the massive deployment of sensors. The piezoelectric device can be widely used in vibration energy harvesting of train, transmission line, engine,and human motion. Vibration energy can be converted into electrical energy through piezoelectric effect. Through power management and storage, wireless sensor nodes can be continuously powered. High power density and reliable PVEH structure design, efficient power management design, and low-power WSN design are the key to achieving sustainable self power supply system. This report will introduce the design and manufacturing of PVEH, management circuits, and self powered wireless sensing technology, as well as their applications in trains, power grids, and human movement.

THE DEVELOPMENT OF CHIP-SCALE ATOMIC CLOCK USING QUANTUM INTERFERENCE EFFECT

Munehisa Takeda was born in Japan in 1957. He received the B.E. and M.E. degrees in Precision Mechanics from Kyoto University in 1979 and 1981, respectively. He also received M.S degree in Bioengineering from UCSF/UCB in 1988 and Dr. of Information Science and Technology degree in Mechano-Informatics from The University of Tokyo in 2020. He joined Mitsubishi Electric Corporation in 1981. After having held general managers of MEMS related departments at Mitsubishi Electric Corporation, he is currently the General Manager of MEMS System Development Center at Micromachine Center and Program-Specific Professor at Education and Research Center for Digital Transformation, Toyama Prefecture University.

Report Abstract:

This presentation introduces the development of chip-scale atomic clocks that utilize quantum interference effects. Chip-scale atomic clocks are important devices for precise timing in many applications, such as navigation, communications, monitoring, and synchronization of sensors and systems. They are essential devices, especially for mobile applications where GNSS satellite signals are disrupted. The cesium atomic clock that determines the global standard time is a large atomic clock that uses a microwave resonator, but it is possible to make a small atomic clock by using CPT resonance (a method of detecting the transition frequency of atoms using light), a type of quantum technology. In addition, MEMS technology is also indispensable for making chip-scale atomic clocks. In this presentation, I will introduce the miniaturization of the physical package of a vibration-resistant chip-scale atomic clock using MEMS technology.

RAILWAY WAYSIDE ACOUSTIC DETECTION USING MICROPHONE ARRAY

Dingcheng Zhang is Associate Professor at Sichuan University, Master's Supervisor. High-level Overseas Study Talent in Sichuan Province, member of the Institute of Electrical and Electronics Engineers (IEEE), member of the Chinese Society for Vibration Engineering, and member of the Chinese Mechanical Engineering Society. PhD graduate in 2020 from the Centre for Rail Research and Education at the University of Birmingham, postdoctoral fellow at City University of Hong Kong. He has hosted and participated in more than ten projects, including the National Natural Science Foundation of China, the Ministry of Science and Technology's Key Research and Development Program, the Sichuan Provincial Key Research and Development Program, the Research Grants Council of the Hong Kong Special Administrative Region, and the Royal Society of the UK, among others. In recent years, he has published sixteen papers in authoritative domestic and international journals such as IEEE Transactions on Intelligent Transportation Systems, Journal of Sound and Vibration, and Journal of Vibration Engineering as the first author and corresponding author. Two of his papers have been selected as ESI highly cited papers with over five hundred citations. He serves as an invited reviewer for more than twenty SCI journals, including Mechanical Systems and Signal Processing and Reliability Engineering and System Safety. He has also been an invited session chair at multiple international conferences and a communication reviewer for the National Scholarship Council and the National Natural Science Foundation of China.

Report Abstract:

With the rapid development of the economy and the increase in national strategic needs, high-speed railway transportation in our country has experienced swift growth. Consequently, the operational safety of high-speed railway transportation has become a focal point of concern for all parties. In recent years, with the continuous emergence of new non-destructive testing technologies and intelligent algorithm paradigms, ensuring the safe operation of train vehicles has become one of the hot topics in railway research. The bogie is a key component of the train, and due to its harsh working conditions, it is prone to equipment failures. This report will introduce researches on Train Wheel Set Bearing Fault Diagnosis Based on wayside Acoustic Detection Using Microphone Array.

ALUMINUM SCANDIUM NITRIDE THIN FILM TRANSDUCERS

Tao Wu is currently a Professor at School of Information Science and Technology, ShanghaiTech University, Shanghai, China. He received the B.S. degree from Zhejiang University, Hangzhou, China, in 2007, the M.S. and Ph.D. degrees from the University of California at Los Angeles, Los Angeles, CA, USA, in 2009 and 2011, respectively. Dr. Wu joined ShanghaiTech University in 2017 and his research interests include, MEMS/NEMS, hybrid piezoelectric acoustic transducers, advanced semiconductor processing and CMOS-MEMS microsystem. Dr. Wu is the Senior Member of IEEE, and serves as the TPC member of IEEE IUS, TRANSDUCERS, APCOT. He has authored or co-authored more than 100 papers in prestigious journals and conferences, including (NPG) Microsystems & Nanoengineering, Nature Comm., JMEMS, IEEE Elec. Devi. Lett., Appl. Phys. Lett., Phys. Rev. Lett., ACS Nano, IEEE T-UFFC, IEEE MEMS, TRANSDUCERS, SENSORS.

Report Abstract:

Aluminum nitride (AlN) based piezoelectric acoustic devices are widely used in RF MEMS, ultrasound, microphone as well as energy harvesting. Piezoelectric micromachined ultrasonic transducers (PMUT) have attracted significant interest in consumer electronics and smart health. Scandium (Sc) doping in AlN thin film has been studied for piezoelectric property enhancement, enabling wideband aluminum scandium nitride (AlScN) resonators and high-performance MEMS transducers. In this work, we report recent development on AlScN thin film as well as PMUT transducers in emerging acoustic imaging fields.

INTRODUCTION OF THE STUDY ON THE HIGH-PRECISION MACHINING OF MOLD AND GLASS MOLDING OF MICRO-NANO STRUCTURES

Yupeng He finished his bachelor and Ph. D. study from Beijing Institute of Technology, and now is the associate professor of school of mechanical engineering of Sichuan University. He focuses on the study on the design of optical micro-nano structures, the micro-nano structures high-precision machining on a large-area mold surface, and the high-efficiency molding of micro-nano structures on optical materials. Some ultra-precision machining technologies have been well applied in the industry. He has host 9 projects from government and industry, and published more than 20 papers on top journals in both mechanical and optics engineering fields.

Report Abstract:

Micro-nano structures with customized shape have enhanced the performance of components in various fields, such as imaging optics, micro-optics, tribology and biomedical engineering. Precision glass molding is now the commonly recognized high-precision and high-efficiency manufacturing method of micro-nano structures glass components. Aiming at the creation and fabrication of micro-nano structures on large-area mold, single-point diamond cutting (SPDC) technologies including turning, milling, grinding and fly-cutting are investigated for addressing micro-nano structures mold cutting of various kinds of materials. Micro-nano structures scaling from 100nm to several hundreds of micrometer are fabricated with suppressed deformation on the mold materials represented by nickel phosphide (Ni-P), and the micro-nano structures fabrication on silicon carbide (SiC) mold with ultra-high hardness is also achieved. For the glass molding, the defects of molded micro-nano structures of glass are investigated in mechanism and solved by optimizing the process parameters. The ultrasonic vibration assisted molding is proposed to improve the interface friction between the mold and glass and increase the fluidity of glass materials at high temperature, which enhances the manufacturing precision of micro-nano structures glass components by glass molding technology.

OPTOELECTRONIC SYNAPTIC DEVICES BASED ON 2D LAYERED MATERIALS

Wenjing Jie obtained her BSc and MSc from the University of Electronic Science and Technology of China. She received her PhD from the Hong Kong Polytechnic University under the supervision of Prof. Jianhua Hao. Now, she works as a full-time professor at Sichuan Normal University. Her research interests include 2D materials, heterostructures, and their electronic and optoelectronic devices.

Report Abstract:

With the continuous development of information technology and artificial intelligence, optoelectronic synaptic devices with high bandwidth, low crosstalk, low power consumption and no latency not only have the advantages of simulating visual neural behavior, but also have broad application prospects in the fields of high-performance computing and artificial intelligence. 2D materials have drawn much attention for the applications in neuromorphic computing and artificial vision system owing to their unique electronic and optoelectronic properties. Recently, our research group reported some synaptic devices based on 2D materials. Synaptic memristors based on BiOI nanosheets exhibit bipolar resistive switching performance with a high on/off ratio up to 10^5 and an ultralow SET voltage of ~ 0.05 V. Furthermore, a novel multifunctional synaptic device based on ferroelectric In_2Se_3/GaSe vdW heterojunction is proposed to emulate the entire biological visual system. Moreover, we design ferroelectric tuned synaptic transistors by integrating 2D black phosphorus (BP) with a flexible ferroelectric copolymer poly(vinylidenefluoride-trifluoroethylene) (P(VDF-TrFE)), demonstrating a high mobility value of 900 cm2 V^{-1} s^{-1}, high on/off current ratio of 10^3 and low energy consumption down to the femtojoule level (~40 fJ). Such optoelectronic synaptic devices based on 2D materials demonstrate potential applications in neuromorphic computing and retina-like vision sensors.

ELECTRODEPOSITION OF CATALYTIC FUNCTIONAL NANOMATERIALS

Yibing Li , Southwest Jiatong University. National Young Talents Awards, Sichuan Tianfu Emei Experts. His research focus on new energy generation, grid clean energy storage, hydrogen energy and fuel cells, new electrochemical energy conversion and energy storage, etc. He has presided over the National Youth Talent Project, the National Natural Science Foundation Project, the National Research Council Project of Australia, and the Natural Science Foundation project of Sichuan Province.

His research has been published on Nature Communications; Angewandte Chemie International Edition; Energy & Environmental Science; Advanced Materials; Advanced Functional Materials; Energy Storage Materials; Advanced Energy Materials etc. The total citation of Google Scholar citations of published papers was over 6400, with an H-index of 42.

Report Abstract:

Electrodeposition is a versatile material fabrication technique for designing catalytic targeted reactions. In this talk, nickel-based electrocatalytic materials are rationally designed and successfully electrodeposited on conductive substrate with unique morphology and heterostructures towards hydrogen-related electrolytic reactions. As a concept, a controlled meter-scale electrode fabricated from electrodeposition was also achieved for industrial-scale water electrolyzers.

INTRODUCTION OF THE HIGH-PERFORMANCE FLEXIBLE 2D MATERIAL NANO DEVICES FOR HIGH-TEMPERATURE APPLICATIONS

Peng Li is currently a full professor at Huazhong University of Science and Technology. He received his bachelor's degree from Tianjin University in Jun. 2007, and Ph.D. degree from Dept. of Precision Instruments at Tsinghua University in Jun. 2012. His main research interest is focused on three aspects: Ultrasensitive microsensors based on low-dimensional materials, Atomic-scale manufacturing techniques, and Near-zero power microsystems.

Report Abstract:

In fields such as aerospace engineering, military defense, and harsh-environment robotics, there is a growing demand for high-temperature photodetectors and integrated circuits. However, current high-temperature photodetectors are characterized by low photoresponsivity (<10 A/W) due to the poor optical sensitivity of commonly used heat-resistant materials. Additionally, traditional high-temperature integrated circuits, particularly those based on silicon carbide (SiC) transistors, are constrained by limitations in flexibility and power efficiency. Consequently, the development of high-performance, flexible, and low-power photodetectors and integrated circuits for extreme environments has become a critical area of research.

To address these challenges, we developed h-BN-encapsulated graphite/WSe_2 photodetectors which can endure temperatures up to 700 °C in air and 1000 °C in vacuum. The devices exhibit unconventional negative photoconductivity (NPC) at high temperatures. Operated in NPC mode, the devices show a photoresponsivity up to 2.2×10^6 A/W, which is ~ 5 orders of magnitude higher than that of state-of-the-art high-temperature photodetectors. Furthermore, the devices demonstrate excellent flexibility, making them well-suited for complex environments. This work provides a common solution for the protection of two-dimensional materials against high temperatures and may promote the exploration of optoelectronic properties of TMDs at ultrahigh temperature.

We also made significant progress in developing high-temperature integrated circuits using two-dimensional (2D) materials. MoS_2 degrade significantly at temperatures above 200°C, making it unsuitable for high-temperature applications. To overcome this limitation, we developed MoS_2 field-effect transistors (FETs) with h-BN encapsulation and graphene electrodes, which can operate at temperatures up to 500°C in air. Compared with metal electrode, devices with graphene-electrode demonstrate superior performance at high temperature (~1 order larger current on/off ratio, 3~7 times smaller subthreshold swing, and 5~9 times smaller threshold voltage shift). We further realize flexible CMOS NOT gate based on the above technique, and demonstrate logic computing at 550 °C. This work may stimulate the fundamental research of novel properties of 2D materials at high temperature, and also paves a way for next generation flexible harsh-environment-resistant integrated circuits.

NANO-FABRICATION OF CARBON-BASED FLEXIBLE SENSOR

Xi Zhang is from the School of Electromechanical and Control engineering of Shenzhen University. Her research interests include carbon based flexible sensors, optoelectronic sensors, micro/nano manufacturing, etc

Report Abstract:

High performance flexible optoelectronic sensors play a crucial role in the field of intelligent manufacturing. In the past, intelligent devices based on rigid sensors were unable to "fit" flexibly. Therefore, we urgently need to develop the next generation of optoelectronic sensors that integrate flexible sensing materials and electronic integrated design. However, the tolerance temperature of flexible substrates is relatively low, and sensitive materials with high photoelectric performance often require high-temperature preparation before being peeled off and transferred to the flexible substrate.

The reporter proposed an electron Cyclotron resonance (ECR) electron excited flexible manufacturing technology. Based on the theory of coupled polaron energy transfer between electrons and atomic bonds, low-energy electrons are used as processing means to directly manufacture carbon based nano films rich in Graphene edges on flexible substrates, and develop ultra-high performance flexible sensors. Based on edge rich carbon based nanofilms, doped with nickel gold alloy, three types of metal carbon film mixed coordination flexible sensors are formed, and directly manufactured on the surface of the flexible substrate and mounted on fabric gloves. This product can be monitored through three types of mixed coordination metal carbon film sensors, while also monitoring photoelectric pulse, bending posture, and in vitro monitoring of sweat and blood glucose. Based on flexible sensor technology, parallel intelligent transmission technology, Bionics, etc., innovative use of self-developed new carbon film sensors, together with fabric gloves, can achieve high-precision signal reading. And using flexible PCB circuits greatly reduces the weight of peripherals. Communicate with mobile phones through Bluetooth modules and display health signals in real-time

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Dr. Jeongdai Jo
Department of Flexible and Printed Electronics, Korea Institute of Machinery and Materials, Republic of Korea

Deadline for manuscript submissions:
31 December 2024

Message from the Guest Editors

Dear Colleagues,

This Special Issue will publish selected papers from the 15th Japan-China-Korea Joint Conference on MEMS/NEMS (JCK MEMS/NEMS 2024, www.jckmemsnems2024.com), 19–21 September 2024 in Chengdu, China. The conference will cover the following main topics:

- Micro/Nano Electro-Mechanical Systems (M/NEMS);
- Micro/Nano-Fabrication including 3D printing;
- Micro/Nano-Actuators and Robotics;
- Micro/Nano-Chemical and Physical Sensors;
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- Micro/Nano-Enabled Wearable Devices;
- Networked Microsystems and IoT Technologies;
- Materials and Device Characterization;
- Integration and Packaging Technologies;
- Modeling and Simulation of Manufacturing Processes;
- Medical Engineering Technology.

Papers attracting the most interest at the conference, or that provide novel contributions, will be selected for publication in *Micromachines*. These papers will be peer-reviewed for validation of research results, developments and applications.

In addition, submissions from others that are not associated with this conference but with themes focusing on MEMS/NEMS technology are also welcome.

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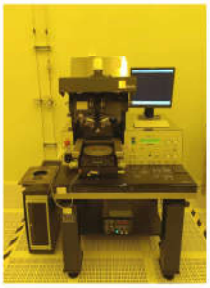
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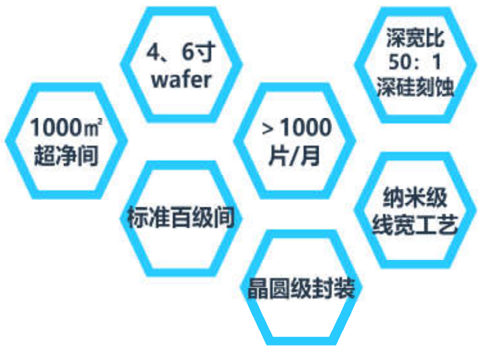

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