ICFE 2021 International Conference on Flexible Electronics

The 3rd International Conference on Flexible Electronics

Nov. 13-14, 2021

Handbook

Organizers: Tsinghua University
Qiantang Science and Technology Innovation Center
Institute of Flexible Electronics Technology of THU, Zhejiang

Contents

Welcome

Dear ICFE 2021 participants,

On behalf of the conference committee, I am pleased to welcome you to attend the 3rd International Conference on Flexible Electronics (ICFE 2021).

The 1st and 2nd International Conference on Flexible Electronics (ICFE 2018 and ICFE 2019) attracted more than 1000 participants from all over the world. The attendees enjoyed, appreciated, and were enriched by the presentations given by the internationally acclaimed speakers. The ICFE 2021 will continue focusing on the diverse frontier areas of flexible electronics, aiming to offer a world's preeminent forum for reporting methodological and technological breakthroughs in flexible electronics, including but not limited to materials, design, fabrication and applications of flexible/stretchable sensors, flexible circuits and microsystems, flexible display, flexible power sources, bio-mimetic electronics, reconfigurable electronics, transient electronics, bio-integrated electronics, wearable electronics, and soft actuators/robots.

I greatly appreciate your interest and participation in ICFE 2021.

Sincerely,

Xue Feng

Chair of Organizing Committee, International Conference on Flexible Electronics
Professor, School of Aerospace Engineering, Tsinghua University, Beijing
Director, Center for Flexible Electronics Technology, Tsinghua University, Beijing

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Program

Venue arrangement

Data	Time	Classification	Topic
November 13 (Saturday)	09:00-09:20	Main venue	Opening Ceremony
	09:20-11:00		Plenary Lectures
	11:00-12:00		Editors' Section
	13:30-16:50	Session-1	New material and structural design of flexible electronics
		Session-2	Novel devices and unconventional fabrication of flexible electronics
		Session-3	Emerging applications and performances of flexible electronics
	16:50-18:00	Main venue	Poster
November 14 (Sunday)	08:30-9:20	Main venue	Plenary Lectures
	09:20-12:30	Session-1	New material and structural design of flexible electronics
		Session-2	Novel devices and unconventional fabrication of flexible electronics
		Session-3	Emerging applications and performances of flexible electronics
	14:00-16:30	Main venue	Plenary Lectures
	16:30-16:50		Closing Ceremony

Main venue

Saturday, November 13, 2021	
09:00-09:20	Opening Ceremony, **chair: Yonggang Huang and Xue Feng**
Plenary Lecture, **chair: Yonggang Huang**	
09:20-10:10	PL-01 ***John A. Rogers***, *Northwestern University*
	Flexible Electronics for Full-Body Haptic Experiences in Virtual and Augmented Reality
Plenary Lecture, **chair: Xue Feng**	
10:10-11:00	PL-06 ***Xiaodong Chen***, *Nanyang Technological University*
	Artificial Senses Technology
Editors' Section, **chair: Yihui Zhang**	
11:00-11:15	ES-02 ***Xin Li***, *Nature Materials*
	Inside Nature Materials
11:15-11:30	ES-03 ***Lu Shi***, *Wiley*
	Advancing Big Ideas with Small Science—How to Maximize Your Success!
11:30-11:45	ES-01 ***Jing Feng***, *Science China Information Sciences*
	Development of Science China Information Sciences
11:45-12:00	ES-04 ***Jie Yang***, *Science China Technological Sciences*
	Publish in Science China, Report Global Advances in Science
16:50-18:00	Poster
Sunday, November 14, 2021	
Plenary Lectures, **chair: Lian Duan**	
08:30-09:20	PL-02 ***Lianmao Peng***, *Peking University*
	Carbon Nanotube based Flexible and High Performance Electronics
Plenary Lectures, **chair: Xue Feng and Yihui Zhang**	
14:00-14:50	PL-04 ***Takao Someya***, *University of Tokyo*
	Electronic Skins and the Next-generation Wearables for Medical Applications
14:50-15:40	PL-03 ***Shuhong Yu***, *University of Science and Technology of China*
	Nanowire Assemblies for Flexible Electronics
15:40-16:30	PL-05 ***Oliver G. Schmidt***, *Chemnitz University of Technology*
	Flexible Electronics: From Highly Integrated "Soft-Wear" to Microrobotic "Hard-Ware"
16:30-16:50	Closing Ceremony, **chair: Xue Feng and Jizhou Song**

Session-1

New material and structural design of flexible electronics

Saturday, November 13, 2021	
Keynote Lectures, **chair: Ye Xu**	
13:30-14:00	KL-01 ***Wenlong Cheng***, *Monash University*
	Programmable Gold Nanowire Electronic Skins and Tattoos
14:00-14:30	KL-07 ***Jiangyu Li***, *Southern University of Science and Technology*
	Freestanding Oxide Films for Flexible Electronics
Invited Lectures, **chair: Ye Xu**	
14:30-14:50	IL-08 ***Yunlong Guo***, *Institute of Chemistry, Chinese Academy of Sciences*
	Flexible Photosensors Based on Organic Transistors
14:50-15:10	IL-25 ***Lan Yin***, *Tsinghua University*
	Biodegradable Materials for Electronic Medicine and Biosensors
Keynote Lectures, **chair: Jiangyu Li**	
15:10-15:40	KL-17 ***Tao Xie***, *Zhejiang University*
	Dynamic Covalent Polymer Network: A Molecular Platform for Flexible Electronics
15:40-16:10	KL-16 ***Jianpu Wang***, *Nanjing Tech University*
	Perovskite LEDs for Lighting and Displays
Invited Lectures, **chair: Jiangyu Li**	
16:10-16:30	IL-10 ***Jia Huang***, *Tongji University*
	Sensors Based on Conjugated Molecules
16:30-16:50	IL-24 ***Ye Xu***, *Beihang University*
	Soft Nanocomposite Materials for Flexible Electronics: From Self-assembly of Nanowires to in Situ Imaging of Microscopic Deformation
16:50-18:00	Poster

Sunday, November 14, 2021	
Keynote Lectures, **chair: Fan Xu**	
09:20-09:50	KL-19 ***Yong Zhu***, *North Carolina State University*
	Silver Nanowire based Soft Electronics
09:50-10:20	KL-11 ***Chaofeng Lü***, *Zhejiang University*
	Ultrathin Flexible Graphene Photodetectors and Its Applications
Invited Lectures, **chair: Fan Xu**	
10:20-10:40	IL-14 ***Ling Wang***, *Tianjin University*
	Stimulus-Driven Liquid Metal and Liquid Crystal Smart Actuators for Programmable Soft Robotics
10:40-11:00	IL-12 ***Yiwei Liu***, *Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences*
	Flexible/elastic Sensitive Materials, Sensors and Smart Clothing Applications
Keynote Lectures, **chair: Chaofeng Lü**	
11:00-11:30	KL-15 ***Guozhen Shen***, *Institute of Semiconductors, Chinese Academy of Sciences*
	Flexible Photodetectors with Semiconducting Nanowires for Non-Contact Control/Communication Applications
Invited Lectures, **chair: Chaofeng Lü**	
11:30-11:50	IL-03 ***Yuan Cheng***, *Monash Suzhou Research Institute*
	Mechanical Properties of Bioinspired Materials and Their Applications in Flexible Electronics
11:50-12:10	IL-20 ***Fan Xu***, *Fudan University*
	Curvature Tunes Wrinkling in Stretched Hyperelastic Films
12:10-12:30	IL-13 ***Enming Song***, *Fudan University*
	Flexible Electronic Systems with Silicon-Nanomembrane Transistor Array as Neural Interfaces

Session-2

Novel devices and unconventional fabrication of flexible electronics

Saturday, November 13, 2021	
Keynote Lectures, **chair: Ying Chen**	
13:30-14:00	KL-10 ***Yuan Lin***, *University of Electronic Science and Technology of China*
	Flexible Bio-Electronic Devices Based on Inorganic Thin Films
14:00-14:30	KL-18 ***Haixia Zhang***, *Peking University*
	Materials and Structures for Flexible Smart System
Invited Lectures, **chair: Ying Chen**	
14:30-14:50	IL-22 ***Wentao Xu***, *Nankai University*
	Artificial Synaptic Devices and Sensorimotor Nerves
14:50-15:10	IL-04 ***Chong-an Di***, *Institute of Chemistry, Chinese Academy of Sciences*
	Organic Thin-film Transistors for Flexible Sensing Applications
Keynote Lectures, **chair: Yuan Lin**	
15:10-15:40	KL-09 ***Pooi See Lee***, *Nanyang Technological University*
	Stretchable and Printable Devices for Human-machine Interface
Invited Lectures, **chair: Yuan Lin**	
15:40-16:00	IL-26 ***Yingying Zhang***, *Tsinghua University*
	Engineering of Carbon Materials toward Soft Electronics
16:00-16:20	IL-21 ***Kaichen Xu***, *Zhejiang University*
	Hybrid Laser Manufacturing of Multifunctional Flexible Sensors and System Integration
16:50-18:00	Poster

Sunday, November 14, 2021	
Keynote Lectures, **chair: Hanqing Jiang**	
09:20-09:50	KL-13 ***Qibing Pei***, *University of California*
	Toward Flexible Electronic and Electromechanical Materials and Devices
09:50-10:20	KL-02 ***Yimao Cai***, *Peking University*
	CMOS-Compatible Flexible Memories and Sensors for Wearable and Implantable Applications
Invited Lectures, **chair: Hanqing Jiang**	
10:20-10:40	IL-15 ***Zhongming Wei***, *Institute of Semiconductors, Chinese Academy of Sciences*
	Polarization-Sensitive Photodetectors based on 2D Layered Semiconductors
10:40-11:00	IL-23 ***Yang Xu***, *Zhejiang University*
	Mid-infrared Communications based on Flexible Graphene Fibers
Keynote Lectures, **chair: Yimao Cai**	
11:00-11:30	KL-04 ***Hanqing Jiang***, *Westlake University*
	Origami-based Metamaterials: Mechanics and Devices
Invited Lectures, **chair: Yimao Cai**	
11:30-11:50	IL-06 ***Chuanfei Guo***, *Southern University of Science and Technology*
	High Performance Electronic Skins and Their Applications in Robots/Human Body
11:50-12:10	IL-05 ***Qi Ge***, *Southern University of Science and Technology*
	3D Printing of Hydrogel-polymer Hybrids and Its Applications in Flexible Electronics
12:10-12:30	IL-17 ***Zhigang Wu***, *Huazhong University of Science and Technology*
	Transferring of Liquid Alloy Circuits onto Curved, Dynamic and Delicate Surfaces

Session-3

Emerging applications and performances of flexible electronics

Saturday, November 13, 2021	
Keynote Lectures, **chair: Li Wen**	
13:30-14:00	KL-08 ***Jing Liu***, *Tsinghua University*
	Liquid Metal Printed Flexible Electronics: From Fundamentals to Industrial Practices
14:00-14:30	KL-14 ***Tianling Ren***, *Tsinghua University*
	Graphene Flexible Devices for Healthcare
Invited Lectures, **chair: Li Wen**	
14:30-14:50	IL-11 ***Xian Huang***, *Tianjin University*
	Flexible Electronics Based on Origami Magnetic Membranes
14:50-15:10	IL-19 ***Xing Sheng***, *Tsinghua University*
	Implantable Optoelectronic Devices for Advanced Neural Interfaces
Keynote Lectures, **chair: Xian Huang**	
15:10-15:40	KL-05 ***Xingyu Jiang***, *Southern University of Science and Technology*
	Liquid Metal/Polymer-Based Flexible Electronics for Theranostic Devices
15:40-16:10	KL-12 ***George Malliaras***, *University of Cambridge*
	Technology for Bioelectronic Medicine
Invited Lectures, **chair: Xian Huang**	
16:10-16:30	IL-16 ***Li Wen***, *Beihang University*
	Physical Intelligence of Bio-inspired Soft Robots
16:30-16:50	IL-09 ***Mengdi Han***, *Peking University*
	Soft, 3D Microsystems for Biomedicine
16:50-18:00	Poster

Sunday, November 14, 2021	
Keynote Lectures, **chair: Jizhou Song**	
09:20-09:50	KL-03 ***Wei Gao***, *California Institute of Technology*
	Skin-Interfaced Wearable Sweat Biosensors
09:50-10:20	KL-06 ***Kourosh Kalantar-Zadeh***, *University of New South Wales*
	Liquid Metals for Synthesizing Electronic Materials
Invited Lectures, **chair: Jizhou Song**	
10:20-10:40	IL-27 ***Huichan Zhao***, *Tsinghua University*
	Long-Life-Cycle and Damage-Recovery Artificial Muscles via Controllable and Observable Self-Clearing Process
10:40-11:00	IL-18 ***Xi Xie***, *Sun Yat-sen University*
	Minimally Invasive Devices for Biomedical Application
Invited Lectures, **chair: Heling Wang**	
11:00-11:20	IL-07 ***Qinglei Guo***, *Shandong University*
	Transferable Inorganic Semiconductor Nanomembranes for Flexible/transient Sensors
11:20-11:40	IL-02 ***Ying Chen***, *Institute of Flexible Electronics Technology of Tsinghua, Zhejiang*
	Grinding Induced Subsurface Damage Study for Ultra-thin and Flexible Silicon Chips
11:40-12:00	IL-01 ***Raudel Avila***, *Northwestern University*
	Modeling Programable Drug Delivery in Bioelectronics with Electrochemical Actuation

Contacts

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General Information

An online format will be adopt of this conference.

◆Conference Language

The official language of the ICFE 2021 is English.

◆For Poster Presenters

The selection time starts from 4:50 pm to 6:00 pm on November 13th. A separate Tencent conference room will be set up for each poster. Please see "List of posters" for room number.

Best posters will be announced prior to the closing ceremony.

Those who do not log in to the Tencent meeting in time will be deemed to have automatically given up the selection.

◆Participation QR Code

VZAN:

Koushare:

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Plenary Lectures

PL-01

Flexible Electronics for Full-Body Haptic Experiences in Virtual and Augmented Reality

John A. Rogers

Northwestern University, USA(jrogers@northwestern.edu)

Abstract

Advanced, immersive systems for virtual and augmented reality (VR/AR) promise to transform the way that we interact with computer-generated environments and, by extension, with one another. Although audio-visual aspects of VR/AR hardware are increasingly well developed, a frontier, underexplored opportunity is in the development of interfaces that add spatio-temporally controlled physical sensations to the VR/AR experience, where the skin, including by not limited to the fingertips, serves as the input interface. This talk introduces a collection of foundational ideas that build on work in skin-integrated electronic for health monitoring, to enable a unique, new class of technology for this purpose – thin, soft, lightweight sheets that embed wirelessly controlled arrays of millimeter-scale vibro-haptic actuators, capable of gently laminating onto the skin at nearly any region of the body. These systems qualitatively expand the VR/AR interface through complex patterns of physical sensory inputs, time-coordinated with visual and auditory cues. The latest systems and examples in social media, medicine, rehabilitation, gaming, entertainment and navigation will be presented.

Biography

Professor John A. Rogers obtained BA and BS degrees in chemistry and in physics from the University of Texas, Austin, in 1989. From MIT, he received SM degrees in physics and in chemistry in 1992 and the PhD degree in physical chemistry in 1995. From 1995 to 1997, Rogers was a Junior Fellow in the Harvard University Society of Fellows. He joined Bell Laboratories as a Member of Technical Staff in the Condensed Matter Physics Research Department in 1997, and served as Director of this department from the end of 2000 to 2002. He then spent thirteen years on the faculty at University of Illinois, most recently as the Swanlund Chair Professor and Director of the Seitz Materials Research Laboratory. In the Fall of 2016, he joined Northwestern University as the Louis Simpson and Kimberly Querrey Professor of Materials Science and Engineering, Biomedical Engineering and Medicine, with affiliate appointments in Mechanical Engineering, Electrical and Computer Engineering and Chemistry, where he is also Director of the recently endowed Querrey-Simpson Institute for Bioelectronics. His research has been recognized by many awards, including a MacArthur Fellowship (2009), the Lemelson-MIT Prize (2011), the Smithsonian Award for American Ingenuity in the Physical Sciences (2013), the MRS Medal (2018), the Benjamin Franklin Medal (2019), the Sigma Xi Monie Ferst Award (2021) and a Guggenheim Fellowship (2021). He is a member of the National Academy of Engineering, the National Academy of Sciences, the National Academy of Medicine, the National Academy of Inventors and the American Academy of Arts and Sciences.

PL-02

Carbon Nanotube based Flexible and High Performance Electronics

Lianmao Peng

Department of Electronics, Peking University, China(lmpeng@pku.edu.cn)

Abstract

Carbon nanotube (CNT)-based electronics has been considered one of the most promising candidates to replace Si complementary metal-oxide-semiconductor (CMOS) technology, which will soon meet its performance limit. In particular CNTs have been investigated for various electronic and optoelectronic device applications, such as sub-10nm CMOS devices which outperform that of state-of-the-art Si based CMOS devices in both speed and power consumption [1-4], flexible electronics [5], as well as idea material for monolithic optoelectronic integration with complementary MOS-compatible signal processing circuit [6-8].

Prototype device studies on individual CNTs revealed that CNT based devices have the potential to outperform Si CMOS technology in both performance and power consumption. With a well-designed device structure and in combination with graphene, it is showed that high-performance top-gated CNT FETs with a gate length of 5 nm can be fabricated. A scaling trend study revealed that sub-10 nm CNT CMOS FETs significantly outperform Si CMOS FETs. In particular, the 5 nm CNT FETs approach the quantum limit of FETs and involve only approximately one electron per switch. The contact length of the CNT CMOS devices has been scaled down to sub-10 nm, and the smallest CMOS inverter yet reported with a total pitch size of 240 nm is demonstrated. These results show that CNT CMOS technology has the potential to substantially outperform that of Si when approaching the quantum limits of a binary logic switch and to extend mainstream CMOS technology in the post-Moore era [1].

Significant progress has been made in fabricating carbon nanotube low-power devices. An efficient way to reduce the power is to lower the supply voltage VDD, but this voltage is restricted by the 60 millivolts per decade thermionic limit of subthreshold swing (SS) in FETs. A Dirac source (DS) with a much narrower electron density distribution around the Fermi level than that of conventional FETs was recently proposed and demonstrated using CNT to reduce SS [2]. In particular, a DS-FET with a carbon nanotube channel provided an average SS of 40 millivolt per decade over four decades of current at room temperature and high device current. When compared with state-of-the-art Si 14-nanometer node FETs, a similar Ion is realized but at much lower supply voltage of 0.5 versus 0.7 volts for Si, and a much steeper SS below 35 millivolts per decade in the off-state.

High purity semiconducting CNTs have also been used as active channel materials for various optoelectronic de-vices, including light emit-ting diodes and photodiodes [6], and as a general platform for building three-dimensional optoelectronic integrated system [7-8].

Reference

[1] C. Qiu et al., Science 255, 271 (2017).
[2] C. Qiu et al., Science 361, 387 (2018).
[3] L.J. Liu et al., Science 368, 850 (2020).
[4] L.-M. Peng et al., Nature Electronics 2, 499 (2019).
[5] L. Xiang et al., Nature Electronics 1, 273 (2018).
[6] L.J. Yang et al., Nature Photonics 5, 672 (2011).
[7] Y. Liu et al., Nature Communication 8, 15649 (2017).
[8] Y. Liu et al., Nature Electronics 1, 644 (2018).

Biography

Lian-Mao Peng received his B.S. in Physical Electronics from Peking University in 1982 and his Ph.D in Physics from Arizona State University in 1988, and spent the following six years working at the University of Oxford. He returned to China in 1995, first as a senior research scientist at the Institute of Physics, Chinese Academy of Sciences, and then jointed the faculty of the Peking University and became the Yangzi Professor of Nanoscale Science and Technology in 1999, Director of the Key Laboratory for the Physics and Chemistry of Nanodevices in 2004, Head of the Department of Electronics in 2007, and Director of the Center for Carbon based Nanoelectronics in 2015. His current research focuses on carbon-based flexible and high performance electronics. He has published over 400 research papers, with citation of over 26000. He is an Academician of the Chinese Academy of Sciences, and Fellow of the Institute of Physics, UK, and a member of the Editorial Advisory Board of Advanced Functional Materials.

PL-03

Nanowire Assemblies for Flexible Electronics

Shuhong Yu

University of Science and Technology of China, China

Abstract

The fabrication of nanowire (NW)-based flexible devices including wearable energy storage devices, flexible displays, electrical sensors, and health monitors has received great attention both in fundamental research and market requirements in our daily lives. Other than a disordered state after synthesis, nanowires (NWs) with designed and hierarchical structures would not only optimize the intrinsic performance, but also create new physical and chemical properties, and integration of individual NWs into well-defined structures over large areas is one of the most promising strategies to optimize the performance of NW-based flexible devices. In this talk, I will introduce our recent efforts on fabrication of NW assemblies for flexible devices, including the assemble strategies, the improvement of performance in NW assemblies, and the integrated multifunctional functionalities for diverse applications.

Biography

Shu-Hong Yu completed PhD in inorganic chemistry in 1998 from University of Science and Technology of China. From 1999 to 2001, he worked in Tokyo Institute of Technology as a Postdoctoral Fellow, and was awarded the AvH Fellowship in the Max Planck Institute of Colloids and Interfaces, Germany. He was appointed as a full professor in 2002 and the Cheung Kong Professorship in 2006. He was elected as an academician of Chinese Academy of Sciences in 2019. He serves as the Director of the Division of Nanomaterials and Chemistry, Hefei National Laboratory for Physical Sciences at Microscale. Currently, he is the Editor-in-Chief of Mater. Chem. Front., and is an associate editor for Sci. China Mater. and EnergyChem, and on the editorial board or advisory board of journals Accounts of Chemical Research, Advanced Materials, Nano Letters, Chemistry of Materials, Materials Horizons, Research, Nano Research, Matter, Trends in Chemistry, and ChemNanoMat. His research interests include bio-inspired synthesis of inorganic nanostructures, self-assembly of nanoscale building blocks, nanocomposites, their related properties and applications. His research work has been cited more than 65,450 citations (H index 139), named as a Highly Cited Researcher from 2014 to 2020.

PL-04

Electronic Skins and the Next-generation Wearables for Medical Applications

Takao Someya

Graduate School of Engineering. The University of Tokyo, Japan(someya@ee.t.u-tokyo.ac.jp)

Abstract

The human skin is a large-area, multi-point, multi-modal, stretchable sensor, which has inspired the development of electronic skin for robots that simultaneously detect pressure and thermal distribution. By improving its conformability, the application of electronic skin has expanded from robots to human bodies reaching a point where ultrathin semiconductor membrane can be directly laminated onto the skin. Such intimate and conformal integration of electronics with the human skin allows continuous monitoring of health conditions. The ultimate goal of the electronic skin is to non-invasively measure human activities under natural conditions, enabling electronic skin and human skin to interactively reinforce each other. In this talk, I will review recent progress in stretchable thin-film electronics for applications to robotics and next-generation wearables and address issues and the future prospect of electronic skin.

Biography

Takao Someya was appointed dean of School of Engineering, the University of Tokyo in 2020, where he has been member of faculty since 1997 and professor since 2009. He also conducted research at Columbia University's Nanocenter and at Bell Labs.

He served on the board of directors of the Material Research Society 2009-2011. He is also Chief Scientist at RIKEN and Team Leader at its Center for Emergent Matter Science since 2015. His expertise is stretchable and organic electronics, developing the world's first stretchable electronic skin for robotic application. He was awarded the 16th Leo Esaki Prize in 2019.

PL-05

Flexible Electronics: From Highly Integrated "Soft - Wear" to Microrobotic "Hard - Ware"

Oliver G. Schmidt

Center for Materials, Architectures and Integration of Nanomembranes (MAIN), TU Chemnitz, Germany School of Science, TU Dresden, Germany
(o.schmidt@ifw-dresden.de)

Abstract

Wafer scale technologies are employed to create ultra-flexible sensor chips [1] and heterogeneous actuator arrays [2] for highly integrated "Soft-Wear" applications. These technologies are also used to system-engineer pristine and freestanding microrobotic devices. Examples are environmentally aware artificial muscles to gently grab and release minute amounts of delicate biological tissue [3] or microelectronic catheters for sensing, manipulation and targeted drug delivery [4]. Untethered autonomy is achieved by on-chip fabricated soft and flexible microbots [5,6] as well as hybrid organisms that are designed and configured for a variety of medical tasks ranging from cancer treatment to artificial reproduction technologies [7,8]. Particular attention will be paid to the challenge of on-board energy supply for autonomously acting smart dust applications [9]. As examples, self-sufficient self-oscillating microsystems [10] as well as biosupercapacitors that occupy less than a nanoliter of volume and operate in blood to drive a complete sensor system will be highlighted [11].

Reference

[1] M. Kondo et al., Sci. Adv. 6, eaay6094 (2020)
[2] B. Bao et al., Adv. Mater. 33, 2101272 (2021)
[3] B. Rivkin et al., Adv. Intell. Syst. 3, 2000238 (2021)
[4] B. Rivkin, M. Medina - Sanchez, D. Karnaushenko, O.G. Schmidt et al., Sci. Adv. (in press)
[5] V. K. Bandari, O. G. Schmidt, Adv. Intell. Syst. 3, 2000284 (2021)
[6] V. K. Bandari et al., Nature Electron. 3, 172 (2020)
[7] M. Medina - Sánchez, O. G. Schmidt, Nature 545, 406 (2017)
[8] C. K. Schmidt et al., Nature Commun. 11, 5618 (2020)
[9] M. Zhu, O. G. Schmidt, Nature 589, 195 (2021)
[10] F. Akbar et al., Sci. Adv. 7, eabj0767 (2021)
[11] Y. Lee et al., Nature Comm. 12, 4967(2021)

Biography

Oliver G. Schmidt holds a Chair for Material Systems for Nanoelectronics at the Chemnitz University of Technology, Germany, and is adjunct Professor of Nanophysics at the Dresden University of Technology, Germany. He is an elected member of the German Academy of Science and Engineering and Honorary Professor at the Fudan University in Shanghai, China. His professional activities bridge across several research fields, ranging from flexible electronics to small scale robotics and biomedical applications. He has received several awards: the Otto-Hahn Medal from the Max-Planck-Society in 2000, the Philip-Morris Research Award in 2002 and the Carus-Medal from the German Academy of Natural Scientists Leopoldina in 2005. In 2013 he was awarded the International Dresden Barkhausen Award, in 2018 he received the Gottfried Wilhelm Leibniz-Prize of the German Research Foundation, and in 2019 he was awarded an Advanced Grant of the European Research Council (ERC). Oliver Schmidt has received two Guinness World Records, one in 2010 for the smallest man-made jet engine and one in 2020 for the smallest microelectronic robot.

PL-06

Artificial Senses Technology

Xiaodong Chen

Innovative Centre for Flexible Devices (iFLEX), School of Materials Science and Engineering, Nanyang Technological University, Singapore
Institute of Materials Research and Engineering, Agency for Science, Technology and Research, Singapore
(chenxd@ntu.edu.sg)

Abstract
Artificial senses refer to the emulation of human's basic senses and assimilate them to functional devices and systems to help us understand and perceive the world around us. This research topic of artificial senses is transdisciplinary and lies at the confluence of materials science, bioengineering, medical sciences, electrical engineering, and computer science. Some use cases, including enhanced sensory capabilities to overcome physical human limitations, improved robotic capabilities and diagnostics with smart information processing, and prosthetics and health-monitoring devices to improve quality of life, are drawing much attention. In this talk, I will present some latest progress in artificial tactile and olfaction with the viewpoint from materials development, sensor fabrication, information processing, and system integration. Artificial senses would be a new enabling technology to construct next-generation intelligent devices and systems, paving the way for advanced soft robotic applications, rehabilitation, prosthetics, and so on.

Biography

Professor Xiaodong Chen is the President's Chair Professor in Materials Science and Engineering, Professor of Chemistry (by courtesy) and Medicine (by courtesy) at Nanyang Technological University, Singapore (NTU), and Scientific Director at the Institute of Materials Research and Engineering, Agency for Science, Technology and Research (A*STAR). He is the Director of Innovative Centre for Flexible Devices (iFLEX) at NTU, the Director of Max Planck – NTU Joint Lab for Artificial Senses, and Deputy Director of Singapore Hybrid-Integrated Next-Generation μ-Electronics (SHINE) Center.

His research interests include mechano-materials science, senses digitalization, flexible electronics technology, and cyber-human interfaces. So far, he has published more than 330 high-profiled papers and filed/applied more than 40 patents. He is the Associate Editor of ACS Materials Letters and serves as editorial advisory board member for more than 15 international journals. He has been elected as a Fellow of the Academy of Engineering Singapore. In addition, he was recognized by more than 10 prestigious awards and honours.

The 3rd International Conference on Flexible Electronics

Nov. 13-14, 2021

Keynote Lectures

（in alphabetical order）

KL-01

Programmable Gold Nanowire Electronic Skins and Tattoos

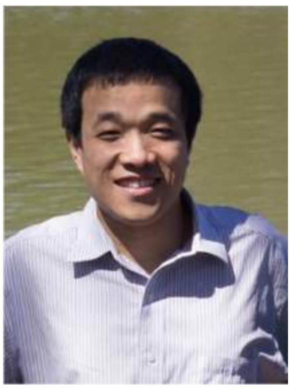
Wenlong Cheng

Department of Chemical&Biological Engineering, Monash University, Australia(Wenlong.Cheng@monash.edu)

Abstract

Sensitive, specific yet multifunctional tattoo-like electronics are ideal wearable systems for health monitoring anytime anywhere because they are virtually becoming parts of Human skins offering burdenless "unfeelable" wearing experience. Here, I will present the skin-like, multifunctional electronic skins and tattoos using standing enokitake mushroom-like vertically aligned nanowire. Among various materials of choices, gold has advantages of biocompatibity, chemical inertness, facile synthesis/Surface functionalisation and band-gap-matching with a lot of semiconductors materials. In this talk, I will discuss our newly developed standing gold nanowire-based soft biosensing platform in the forms of patches, fibers and tattoos. Combining it with local cracking technology, we can arbitrarily fine-tune desired sensitivity and stretchability of gold nanowire electronic tattoos by programming localized crack size, shape and orientations. Furthermore, we demonstrate in-plane integration of strain/pressure sensor, anisotropic orientation-specific sensors, strain-insensitive stretchable interconnects, temperature sensors, glucose sensors, and lactate sensors without the need of soldering or gluing.

Biography



Wenlong Cheng is a professor and director of research in the Department of Chemical&Biological Engineering at Monash University, Australia. He is currently a fellow of Royal Society of Chemistry and was also an Ambassador Tech Fellow in Melbourne Centre for Nanofabrication. He earned his PhD from Chinese Academy of Sciences in 2005 and his BS from Jilin University, China in 1999. He was Alexander von Humboldt fellow in the Max Planck Institute of Microstructure Physics and a research associate in the Department of Biological and Environmental Engineering of Cornell University. He founded Monash NanoBionics lab at the Monash University in 2010. His research interest lies at the Nano-Bio Interface, particularly self-assembly of 2D plasmonic nanomaterials, DNA nanotechnology, electronic skins and stretchable energy devices. He has published >180 papers including 3 in Nature Nanotech, 1 in Nature Mater, 1 in Nature Comm and 1 in Nature Protocol. He is currently the scientific editor for Nanoscale Horizon (Royal Society of Chemistry) and the editorial board members for a few journals including iScience, Chemosensors, and Austin Journal of Biomedical Engineering.

KL-02

CMOS-Compatible Flexible Memories and Sensors for Wearable and Implantable Applications

Yimao Cai

School of Integrated Circuits. Peking University, China(caiyimao@pku.edu.cn)

Abstract

The flexible devices including logic devices, memories and sensors are essential to wearable and implantable applications. In this talk the main challenges of fabrication and performance optimization of organic flexible devices are discussed. A CMOS-compatible platform for fabrication and integration of flexible devices are introduced, on which various memory devices and sensors based on polychloro-para-xylylene (parylene-C) were demonstrated, showing excellent chemical stability and multi-functionalities as well as low operation power.

Biography

Yimao Cai received the Ph.D. degree in Microelectronics from Peking University, Beijing, China, in 2006. From 2006 to 2009, he was with R&D center, Samsung Electronics, Korea, where he contributed to the development of 65 nm/45 nm NOR flash chips and their characterization. In 2009, he joined Institute of Microelectronics, Peking University, where he is currently a Professor and the Chair of the Department of Microelectronics. He is the holder of ~30 granted patents and has authored or coauthored four books and over 100 papers. He is the winner of National Science Fund for Distinguished Young Scholars. His research interests include flexible devices, memory technologies and the brain-inspired computing technologies.

KL-03

Skin-Interfaced Wearable Sweat Biosensors

Wei Gao

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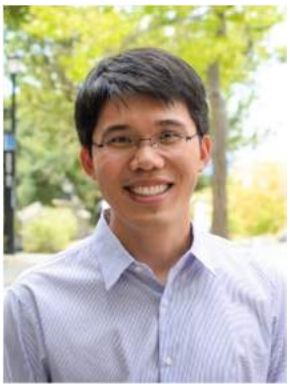
Abstract

The rising research interest in personalized medicine promises to revolutionize traditional medical practices. This presents a tremendous opportunity for developing wearable devices toward predictive analytics and treatment. In this talk, I will introduce our efforts in developing fully-integrated skin-interfaced biosensors for non-invasive molecular analysis. Such wearable biosensors can continuously, selectively, and accurately measure a broad spectrum of sweat analytes including metabolites, electrolytes, hormones, drugs, and other small molecules. The clinical value of our wearable sensing platforms is evaluated through multiple human studies involving both healthy and patient populations toward physiological monitoring, nutritional monitoring, disease diagnosis, mental health assessment, and drug personalization. This talk will feature our recent works on self-powered battery-free electronic skins and mHealth-based biosensors for multiplexed COVID-19 diagnosis and management. These wearable and flexible devices could open the door to a wide range of personalized monitoring, diagnostic, and therapeutic applications.

Biography



Wei Gao is an Assistant Professor of Medical Engineering, a Ronald and JoAnne Willens Scholar, and a Heritage Medical Research Institute (HMRI) Investigator in Division of Engineering and Applied Science at the California Institute of Technology. He received his Ph.D. in Chemical Engineering at University of California, San Diego in 2014. In 2014–2017, he was a postdoctoral fellow in the Department of Electrical Engineering and Computer Sciences at the University of California, Berkeley. He is an Associate Editor of Science Advances. He is a recipient of Pittsburgh Conference Achievement Award, Office of Naval Research (ONR) Young Investigator Award, Sloan Research Fellowship, IEEE EMBS Early Career Achievement Award, IEEE Sensor Council Technical Achievement Award, 3M Non-Tenured Faculty Award, MIT Technology Review 35 Innovators Under 35, and ACS DIC Young Investigator Award. He is a World Economic Forum Young Scientist, a member of Global Young Academy, a Highly Cited Researcher (Web of Science), and a National Academy of Engineering US Frontiers of Engineering Symposium alumnus. His research interests include wearable devices, biosensors, flexible electronics, micro/nanorobotics, and nanomedicine.
For more information about Gao's research, visit www.gao.caltech.edu.

KL-04

Origami-based Metamaterials: Mechanics and Devices

Hanqing Jiang

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Abstract

Origami, the art of paper folding, is being transformed by scientists, mathematicians, and engineers into innovative design approaches to harness its unique properties, i.e., creating deployable structures with tunable properties. Inspired by one of the central themes of origami, i.e., compactness and deformability of the folded structures, this talk will be started by presenting origami-based deformable electronics, including origami-based solar cells, lithium-ion batteries, and kirigami-based batteries, followed by a mechanics analysis of the stability of origami structures for on-demand deployability and compressibility through designed loading and unloading passes. Finally, curved origami patterns were discussed to enable in-situ stiffness manipulation covering negative, zero, and positive stiffness. These studies open ways to design origami-based mechanical metamaterials with variable applications.

Biography

Hanqing Jiang is a Professor of Engineering at Westlake University in China. Before joining Westlake University in June 2021, he was a faculty member of Mechanical Engineering at Arizona State University from 2006 to 2021. He received his Ph.D. from Tsinghua University in 2001, majoring in Solid Mechanics. His current research interests include the origami and kirigami based mechanical metamaterials, mechanics of lithium-metal batteries, and unconventional electronics. He has published 5 book chapters and more than 130 peer-reviewed journal papers. Many of his papers are among the top cited papers in mechanics and/or mechanical engineering communities. He was elected to an ASME Fellow in 2016. He is the newly elected vice president of the Society of Engineering Science and will be the president of SES in 2022. He is a member of the executive committee of the Materials Division of ASME and will be the chair of this committee in 2025.

KL-05

Liquid Metal/Polymer-Based Flexible Electronics for Theranostic Devices

Xingyu Jiang

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Abstract

Conductive inks made from lipid metals-polymer composites (MPC) can be printed into patterned circuits to fabricate flexible devices that have excellent conductivity, flexibility, stretchability, biocompatibility, and conformability. These properties can dramatically expand the capability of electronics in a variety of biomedical applications, such as biomedical sensing/diagnostics, tissue engineering, regenerative medicine and so forth. The greatest advantage of MPC is that Ga, the metal used for the conducting part of the devices is completely biocompatible and biodegradable. The polymeric part of MPC used as the insulator can deploy Food & Drug Administration-approved materials. Thus MPC can be useful for not only external surfaces, but also internal surfaces of the human body. Epidermal liquid metal-based electronics, such as blood oxygen sensor and sweat detection device, allow real-time digital feedback of health information. Meanwhile, implantable medical implements can be used to treat cardiovascular disease, such as small-diameter artificial blood vessels for promoting endothelialization, degradable temporary cardiac pacing lead for correcting abnormal heart rate and implantable stent with electroporation for gene delivery. I will also discuss the idea of an "electronic blood vessel" in particular and a related concept of "electronic vascularized tissues/organs" in general.

Biography

Xingyu Jiang is a Chair Professor at the Southern University of Science and Technology, Shenzhen, China. He obtained his B.S. at the University of Chicago in 1999 and his Ph.D. at Harvard University in 2004. In 2005, he began to start his own lab at the National Center for Nanoscience and Technology (an affiliate of the Chinese Academy of Sciences). In 2018, he was appointed the Head and Chair Professor at the Department of Biomedical Engineering of the Southern University of Science and Technology. He has published more than 300 peer-reviewed papers. His research has been recognized by many awards and supported by a number of prestigious funding, including "Hundred Talents Plan" of the Chinese Academy of Sciences, the National Science Foundation of China's Distinguished Young Scholars Award, the Scopus Young Researcher Gold Award, and the Human Frontier Science Program Young Investigator Award. He is a Fellow of the Royal Society of Chemistry (UK) and the American Institute of Medical and Biological Engineering.

KL-06

Liquid Metals for Synthesizing Electronic Materials

Kourosh Kalantar-Zadeh

School of Chemical Engineering, University of New South Wales (UNSW), Kensington NSW, Australia

Abstract

Low melting point liquid metals are materials with rich chemistries and physics. This talk presents some of the fundamental concepts regarding liquid metals can offer in the field of electronics and flexible systems. The talk includes a discussion on how metallurgy of liquid metals in exploited to gain peculiar advantages for the creation of low dimensional compounds, specifically materials with applications in electronics. The talk will focus on how by direct alloying, and taking advantage of interfacial layering/competition or crystallinisation of the added elements, or by using the ultrasmooth surface of liquid metals, as the templating environment, functional electronic materials can be created. Eventually it will be shown that liquid metals can be used for creating electronic units either semiconducting or conductive that can be bent. It will be shown how liquid metals based systems can offer benefits to the future of electronics technologies.

Biography

Kourosh Kalantar-Zadeh is a professor of Chemical Engineering at University of New South Wales (UNSW). He is one of the Australian Research Council (ARC) Laureate Fellows of 2018. Prof. Kalantar-Zadeh is involved in research in the fields of materials sciences, electronics, and transducers. He has co-authored of nearly 500 scientific papers and books and is also a member of the editorial boards of journals including ACS Applied Nano Materials, ACS Sensors, Advanced Materials Technologies, Nanoscale and ACS Nano. He has received many international awards including the 2017 IEEE Sensor Council Achievement, 2018 ACS Advances in Measurement Science Lectureship awards and also 2020 RSC Robert Boyle Prize for Analytical Science. His name also appeared in the Clarivate Analytics most highly cited list since 2018.

KL-07

Freestanding Oxide Films for Flexible Electronics

Jiangyu Li

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Abstract

Making inorganic oxides flexible is a longstanding challenge, and recent development utilizing water-soluble $Sr_3Al_2O_6$ as a sacrificial layer to fabricate freestanding oxide films offers a promising strategy for flexible electronics based on inorganic materials. In this talk, I will briefly review the state of art in this field, and present our work in freestanding ferroelectric, ferromagnetic, and multiferroic materials and heterostructures. All-inorganic flexible electronic devices based on mica substrate will also be discussed.

Biography

Jiangyu Li recently joins Southern University of Science and Technology, and serves as the Chair in the Department of Materials and Science and Engineering. Prior that, he was a Research Scientist at Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, and a Professor in the Department of Mechanical Engineering, University of Washington. Li works in the general field of mechanics and physics of materials, focusing on advanced scanning probe microscopy and its applications in functional materials. He has published over 200 journal articles, and has been recognized by Sia Nemat-Nasser Medal from ASEM, Young Investigator Award from ICCES, and Microscopy Today Innovation Award from Microscopy Society of America. He currently serves as Associate Editor for Journal of Applied Physics and Science Bulletin, and serves on the Editorial Board of npj Computational Materials and Theoretical and Applied Mechanics Letters.

KL-08

Liquid Metal Printed Flexible Electronics: From Fundamentals to Industrial Practices

Jing Liu

Department of Biomedical Engineering, School of Medicine, Tsinghua University, China
Technical Institute of Physics and Chemistry, Chinese Academy of Sciences, China
(jliubme@tsinghua.edu.cn)

Abstract

Conventional electronic manufactures are usually complicated, time, material and energy consuming, and may generate potential pollutions to the environment. In a decade before we proposed an alternative way termed as Liquid Metal Printed Electronics to quickly fabricate electronic circuits and functional devices in a moment. The following years witnessed increasing breakthrough progresses in both academics and industries which significantly stimulated rapid formation of this new area. Unlike the traditional way, such game changing strategy offers many extraordinary opportunities for electronic fabrication such as: idealistic flexibility, pervasive adaptability, personalized design, large area printing, low cost, high performance, and environmental friendliness. More uniquely, it allows customize electronic products on demand to print electronics spanning from 2D plane surface to 3D structure and on any target substrates. This deems it to reshape modern electronics and integrated circuits. So far, a variety of critical advancements have been made in developing liquid metal electronic inks, printing machines and innovative applications etc. This talk is dedicated to present an overview on the fundamental principles and technological inventions of the liquid metal printed electronics. A series of key desktop printing machines thus brought about and their diverse capabilities in making personal electronics, flexible and transparent circuit, sensor, smart home appliances including skin electronics, wearable health care devices etc. will be introduced. Several milestone products and equipment in industry will also be illustrated. In addition, the major R&D directions and future challenges to tackle the wide range use of liquid metal printed flexible electronics will be clarified. Prospects will be interpreted for the new era that each one can freely print out customer end electronic device as desired. Overall, the emergence of the Liquid Metal Printed Electronics opens plenty of spaces to explore and practice for the society. It would foster new science, technology and industry and expect an ever exploded prosperity in the coming time with endless endeavors input throughout the world.

Biography

Dr. Jing Liu is a jointly appointed Professor of Tsinghua University (THU) and Technical Institute of Physics and Chemistry, Chinese Academy of Sciences. He received his double bachelor's degrees (B.E. in Engineering & B.S. in Physics) in 1992, and Ph.D. (in Engineering and Biomedicine) in 1996, all from THU, and had ever been a Post Doctorial Research Associate at Purdue University and a Senior Visiting Scholar at Massachusetts Institute of Technology. Dr. Liu intensively works at the interdisciplinary areas among liquid metals, biomedical engineering and thermal science. He pioneered a group of pivotal fundamental discoveries and technological breakthroughs on liquid metals covering liquid metal chip cooling, liquid metal printed electronics and 3D printing, liquid metal biomaterials and transformable liquid metal machines etc. which were frequently featured over the world. Many of his inventions have been widely adopted in industry and by the society. Also, Dr. Liu proposed and helped initiate the China Liquid Metal Valley and the new industry therein. He is a recipient of numerous awards like: The William Begell Medal (issued internationally to only an individual every four years), 2015 R&D 100 Awards Finalist, 2010-2011 Best Paper of the Year Award from ASME Journal of Electronic Packaging, CCTV 2015 Top Ten Figures in Science and Technological Innovation and ten times highest teaching awards from CAS and THU etc.

KL-09

Stretchable and Printable Devices for Human-machine Interface

Pooi See Lee

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Abstract

To realize conformable and wearable devices, approaches to fabricate flexible and stretchable devices have embraced extensive exploitation of materials for active coatings, functional printing and revolutionary modifications of typical conventional rigid substrates. Active coating using inkjet printing has been used to realized flexible and stretchable electrochromic devices. 3D printed kirigami stretchable piezoelectric energy harvesters were fabricated using formulated ink and printable elastic conductor, which allowed it to operate in pressing mode with output voltage unperturbed up to 300% strain. Stretchable and printable urethane-based elastomeric material has been used to realize stretchable triboelectric energy harvester. In addition, a hydrophilic urethane-acrylate elastomer has been used as a binder for the fabrication of stretchable battery which utilized sweat as the electrolyte. On the other hand, ionic conductors made of hydrogels and ionogels can be used as highly transparent deformable electrodes. Ionic gel electrodes can be inkjet-printed onto elastomer substrates for proximity sensing and multi-touch applications. Stretchable ionic conductor with optimized ratio of chemically linked ionic chains has led to high thermal stability and self-healability for actuators and thermal sensors.

Biography

Prof. Pooi See Lee received her Ph.D. from the National University of Singapore in 2002. She joined the School of Materials Science and Engineering, Nanyang Technological University as an Assistant Professor in 2004. She was promoted to tenured Associate Professor in 2009 and full Professor in 2015. Her research focuses on nanomaterials for energy and electronics, flexible and stretchable devices, human-machine interface and functional materials for soft robotics. She received the National Research Foundation Investigatorship and Nanyang Research Excellence Award in 2016. In 2018, she received the Nanyang Innovation and Entrepreneurship Award. She served as the Associate Dean (Faculty) in College of Engineering from 2016 before appointed as the Dean of Graduate College in 2020. Prof Lee is currently a senior editor in ACS Energy Letters and also the editorial advisory board member in several journals. She is elected as the National Academy of Inventors (NAI) Fellow in 2020, the highest professional distinction accorded solely to academic inventors.

KL-10

Flexible Bio-Electronic Devices Based on Inorganic Thin Films

Yuan Lin

University of Electronic Science and Technology of China, China(linyuan@uestc.edu.cn)

Abstract

Flexible bioelectronics have attracted increasing interests because they can provide conformal contact and seamless interactions with humans, which would find huge applications in real-time in-situ health monitoring and disease diagnosis. Among them, flexible electronics based on inorganic thin-films are rapidly developed due to the advantages of mature processibility and rich physicochemical properties of inorganic materials. In this talk, I will briefly introduce the development of flexible inorganic thin film devices and present some examples of their applications in biosensing and non-pharmacological stimulation treatments. Challenges and opportunities for future flexible bioelectronics will also be discussed.

Biogqraphy

Yuan Lin is currently a Professor at School of Materials and Energy, University of Electronic Science and Technology of China. Dr. Lin received her Ph.D. degree in Condensed Matter Physics from University of Science and Technology of China in 1999. After that, she had worked in the University of Houston and Los Alamos National Lab as a postdoc, and in Intel Corp as a senior engineer. In 2008, she joined the faculty of University of Electronic Science and Technology of China as a Yangtze River Scholars Distinguished Professor. Dr. Lin is active in the field of electronic thin films and devices. Her main research interests are focused in the development of various thin films (such as ferroelectric oxide, vanadium oxide and other oxides) for applications in electronic devices, especially in stretchable and flexible electronic devices.

KL-11

Ultrathin Flexible Graphene Photodetectors and Its Applications

Chaofeng Lü

College of Civil Engineering and Architecture, Zhejiang University, China
Soft Matter Research Center, Zhejiang University, China
(lucf@zju.edu.cn)

Abstract

High-performance photodetectors have significant applications in a wide range of areas such as video imaging, optical communications, fire detection, biomedical imaging, environmental monitoring and space exploration. Here, we have successfully fabricated arrays of flexible photodetectors based on Si/Graphene heterojunction, which can not only be used in wet or even liquid environment, but also achieve good conformal adhesion with biological tissues and soft materials. The photodetectors exhibit excellent performance, with high responsivity, fast response speed and good stability. The experiment shows that the detectors have a wide spectral response ranging from ultraviolet, visible to infrared, and even respond to x-rays. As examples of the potential application of the detectors, we explore the feasibility of the circuits for detection for growing and deformation of materials, bio-organs, and engineering structures, based on the change of light intensity during deformation acquired by the detector. Simples theoretical models are also established to correlate the nonlinear deformation and the light intensity. Flexible stretchable arrays of photodetectors prepared by this process have a large number of photosensitive units, and the density of the detectors can be adjusted according to various practical applications.

Biography

Dr. Lü is currently Qiushi Distinguishied Professor at Zhejiang University and Associate Dean of College of Civil Engineering and Architecture (CCEA). Upon receiving his Ph.D. degrees in Structural Engineering from Zhejiang University in 2006, Dr. Lü joined CCEA Zhejiang University as an Assistant Professor, and promoted to Associate Professor in 2008 and full Professor in 2013. During this period, he jointly worked as Research Fellow in City University of Hong Kong from 2007 to 2009 and Visiting Scholar in Northwestern University from 2010 to 2012.

Dr. Lü's research interests include mechanics of smart materials and structures, flexible/stretchable electronics with particular applications in bio-integrated devices, and growth of materials and self-assembly. He has co-edited one book chapter and co-authored over 110 refereed international journal articles and 50 international conference papers. These publications have received more than 4800 self-excluded independent SCI citations with an H-index 32. He is the recipient of academic awards include the NSFC Distinguished Young Scientist (2019), MOE Changjiang Scholar Young Scientist (2017), National Natural Science Award (2015), NSFC Outstanding Young Scientist (2013), and MOE Natural Science Award (2012). He is now the Director of the Electronic and Electromagnetic Devices Mechanics Division of CSTAM, the Associate Editor of Nano Communications (2015-), and editor board member of Mechanics of Advanced Materials and Structures, Chinese Journal of Theoretical and Applied Mechanics, Forces in Mechanics, Sensors, and Materials.

KL-12

Technology for Bioelectronic Medicine

George Malliaras

Department of Engineering, University of Cambridge, UK(gm603@cam.ac.uk)

Abstract

As the discovery of new drugs becomes slower and more expensive with time, there is an urgent need for a new approach to treating disease. Bioelectronic medicine, which uses electrical stimulation to influence neural behaviour, has emerged as a powerful technology to that end: Deep brain stimulation, for example, has shown exceptional promise in the treatment of neurological and neuropsychiatric disorders, while stimulation of peripheral nerves is being explored to treat autoimmune disorders. To bring these technologies to patients at scale, however, significant challenges remain to be addressed. Key among these is our ability to establish stable and efficient interfaces between electronics and the human body. I will show examples of how this can be achieved using new electronic materials and devices engineered to communicate with the body and evolve with it.

Biography

George Malliaras is the Prince Philip Professor of Technology at the University of Cambridge. He received a PhD from the University of Groningen, the Netherlands and did a postdoc at the IBM Almaden Research Center, USA. Before joining Cambridge, he was a faculty member at Cornell University in the USA, where he also served as the Director of the Cornell NanoScale Facility, and at the School of Mines in France. His research has been recognized with awards from the New York Academy of Sciences, the US National Science Foundation, and DuPont, and an Honorary Doctorate from the University of Linköping in Sweden. He is a Fellow of the Materials Research Society and of the Royal Society of Chemistry and serves as Deputy Editor of Science Advances.

KL-13

Toward Flexible Electronic and Electromechanical Materials and Devices

Qibing Pei

Soft Materials Research Laboratory, Department of Materials Science and Engineering, University of California, Los Angeles, USA(qpei@seas.ucla.edu)

Abstract

The emergence of devices that combine rubbery elasticity with electronic properties offers exciting new opportunities for applications, but brings significant materials challenges. This presentation will describe our findings in the materials development and device demonstration on elastomeric dielectrics, semiconductors, and conductors. Carbon nanotube and silver nanowire-polymer composites are synthesized as a new generation of transparent electrode to replace ITO with added mechanical flexibility. Elastomeric semiconductors are explored to demonstrate stretchable light emitting diodes, solar cells, and thin film transistors. A solid state cooling device based on a flexible electrocaloric (ECE) polymer film and an electrostatic actuation mechanism will also be presented.

Biography

Qibing Pei is Professor of Materials Science and Engineering and Affiliate Professor of Mechanical Engineering at the University of California, Los Angeles. He specializes in synthetic polymers and composites for electronic, electromechanical, and photonic applications, with 220 peer-reviewed journal publications and 44 granted US patents. His current research activities focus on stretchable electronics, nanostructured polymer composites, dielectric polymers for actuation, energy generation, energy storage, and electrocaloric cooling. He received B.S. degree from Nanjing University and PhD degree from the Institute of Chemistry, Chinese Academy of Sciences. He was a postdoctoral fellow in Linköping University, Sweden, a senior chemist at UNIAX Corporation (now DuPont Display), and a senior research engineer at SRI International. He joined the UCLA faculty as a full professor in 2004 and has been directing the UCLA Soft Materials Research Laboratory. He is a Fellow of SPIE, member of ACS, SID, and MRS, Associate Editor of Smart Materials & Structures, and Editorial/Advisory Board Member of Soft Robotics, Advanced Electronic Materials, Advanced Fiber Materials, and Scientific Reports.

KL-14

Graphene Flexible Devices for Healthcare

Tianling Ren

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Abstract

Nowadays, the traditional face-to-face diagnosis mode between patients and doctors cannot meet people's growing demand for healthcare, and the traditional diagnosis mode needs to be further improved in the utilization efficiency of time and resources. Compared with traditional electronic devices and systems, flexible devices have the characteristics of ultra-thin, low modulus of elasticity, light weight and good tensile properties. They have wide application prospects in consumer electronics, biomedicine and many other fields. Especially as a flexible device for physiological signal detection and monitoring, it has become an important academic research frontier to measure various signal changes in human activities. This talk will introduce the important breakthrough of flexible electronic technology in recent years, especially the progress in graphene flexible electronics. The prospect of wearable flexible electronic technology will also be given.

Biography

Prof. Ren is Vice Dean of School of Information Science and Technology of Tsinghua University. He has been full professor of Institute of Microelectronics of Tsinghua University since 2003. He was visiting professor at Department of Electrical Engineering of Stanford University from 2011 to 2012. Prof. Ren's researches are focused on the intelligent sensor and integrated system. He paved the way for fabricating graphene devices in large scale efficiently. Prof. Ren greatly broaden graphene's application in wearable sensor, acoustical device, memory, and synapse transistor. He has published over 600 journals or conference articles, including Nature Electronics, Nature Communications, Energy & Environmental Science, Advanced Materials, ACS Nano, Nano Letters, IEEE EDL, IEEE JSSC, IEEE Sensors Journal, and IEEE IEDM.

KL-15

Flexible Photodetectors with Semiconducting Nanowires for Non-Contact Control/Communication Applications

Guozhen Shen

Institute of Semiconductors, Chinese Academy of Sciences, China(gzshen@semi.ac.cn)

Abstract

As an important candidate among the family of flexible electronic devices, flexible photodetector with excellent mechanical flexibility, stretchability and optoelectronic performance has wide applications including binary switches in imaging techniques, light-wave communications, sensors, missile-launch detection, machine vision, short wave infrared surveillance and near infrared medical imaging. Semiconductor nanowires (NWs) with unique geometric structure, good transparency, and excellent electronic/optoelectronic properties, provide many opportunities and capabilities for the application of flexible photodetectors. In this talk, I will introduce the most recent progress of flexible photodetectors with semiconducting nanowires as the sensing elements, mainly focusing on our own work. The basic structure and characteristic parameters of flexible nanowire photodetectors were first introduced, followed with the demonstration of flexible photodetectors for the applications of non-contact control and communications.

Biography

Guozhen Shen is currently a professor and group leader in the Institute of Semiconductors, Chinese Academy of Sciences. He received his Ph.D degree (2003) in Chemistry from University of Science and technology of China. His current research focused on flexible electronics and printable electronics, including transistors, photodetectors, sensors and flexible energy storage and conversion devices. He made great contributions to the development of flexible image sensors for artificial visual systems and flexible sensors for health monitoring. Dr. Shen has published more than 300 papers in international referred journals with an h-factor of 79. He edited 2 books on flexible electronics and nanowire electronics. Dr. Shen is the recipient of the NSFC Outstanding Young Scholars, 2nd Prize of the Science and Technology Award of Beijing, and the 1st Prize of the Science and Technology Award of C-MRS.

KL-16

Perovskite LEDs for Lighting and Displays

Jianpu Wang

Key Laboratory of Flexible Electronics (KLOFE) & Institute of Advanced Materials (IAM), Nanjing Tech University, China(iamjpwang@njtech.edu.cn)

Abstract

Solution-processed light-emitting diodes (LEDs) are attractive for applications in low-cost, large-area lighting sources and displays. Organometal halide perovskites can be processed from solutions at low temperatures to form crystalline direct-bandgap semiconductors with intriguing optoelectronic properties, such as high photoluminescence yield, good charge mobility and excellent color purity. In this talk, I will present our effort to boost the efficiency of perovskite LEDs to a high level which is comparable to organic LEDs. More importantly, organic LEDs are difficult to maintain high efficiency at high current densities due to their excitonic nature and low charge mobilities. Low temperature solution-processed perovskite LEDs demonstrate remarkably high efficiency at high current densities, suggesting unique potential to achieve large size planar LEDs with high efficiency at high brightness.

Biography

Jianpu Wang has been a professor at Nanjing Tech University since 2013. His research interests are organic/perovskite semiconductor devices and device physics, aiming for display and energy applications. In 2009-2013, he was a postdoctoral research associate studying organic magnetic field effect in Cavendish Laboratory, University of Cambridge. And he did his PhD study also in Cavendish from 2006 to 2009, when he investigated organic semiconductor/inorganic nanocrystal devices. Prof. Wang worked as a research engineer in Samsung Electronics in South Korea in 2003-2006, for developing OLED displays by using ink-jet printing technology.

KL-17

Dynamic Covalent Polymer Network: A Molecular Platform for Flexible Electronics

Tao Xie

College of Chemical and Biological Engineering, State Key Laboratory of Chemical Engineering, Zhejiang University, China(taoxie@zju.edu.cn)

Abstract

Dynamic covalent polymer networks offer unusual opportunities beyond classical thermoplastic and thermoset polymers. In the last five years, my group has been working on the use of readily accessible covalent bonds (ester, urethane, urea etc) to design functional polymer networks with dynamic characteristics. In this talk, I will demonstrate how the general principle of dynamic bond exchange can be applied to program a diverse set of polymer attributes including shape, actuation, stress, and physical properties. The versatility to program polymers can potentially impact many engineering applications, most notably as a functional substrate to broaden the scope of flexible electronics.

Biography

Tao Xie is Qiushi chair professor at the College of Chemical & Biological Engineering, Zhejiang University. He obtained his BS and MS degrees in Polymer Chemistry from Zhejiang University in 1993 and 1996, respectively. From University of Massachusetts at Amherst, he received his Ph. D in Polymer Science & Engineering in 2001. He had since worked at the General Motors Global Research Lab and HRL Laboratories before returning to China in 2013. His current research interests include dynamic covalent polymer networks, shape memory polymers, and 3D/4D printing. He is the inventor of over 80 patent and a recipient of Omnova Solution award (2001), R&D 100 award (2013), and Wang Baoren Award (2019, Chinese Chemical Society). He is an elected fellow of ACS PMSE division and currently serves as an Associate Editor for ACS Applied Materials & Interfaces.

KL-18

Materials and Structures for Flexible Smart System

Haixia Zhang

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Abstract

The field of stretchable electronics has been developed rapidly in recent years due to their potential importance in diverse fields. Long-term power supply of such electronics requires high performance energy harvester, among different choices, triboelectric generator has big advantage with its wide choice of materials. Stretchable conductive composite is one of the most promising materials for constructing stretchable and flexible triboelectric generators.

In this talk, we provide an introduction of how the conductive paths are formed inside soft elastomer based on percolation theory. Three main methods for preparing conductive composite including their remarkable advance and technological issues are summarized. Finally, various flexible triboelectric generators with active sensing function relying on the conductive composite are presented to demonstrate its wide application area, such as, healthcare, prosthesis, and smart robotics, etc.

Biography

Prof. Haixia (Alice) Zhang is Professor at Institute of Microelectronics of Peking University. She received Ph.D. degree in Mechanical Engineering from the Huazhong University of Science and Technology in 1998. She joined Peking University in May 2001 and created her research lab “Alice Wonderlab”, at 2007 she promoted to full Professor. Dr. Zhang has received National Invention Award of Science & Technology at 2006, Geneva Invention Gold Medal at 2014, National Education Award at 2018. She was listed in Forbes Top 50 Female Scientists at China in 2020. Prof. Zhang has published 150 SCI papers with more than 2500 citations and and a principal leader of more than 50 research and collaborative projects. She is a Senior Member of IEEE and served as the General Chair of IEEE MEMS2021 and IEEE NEMS2021. She is the founder of iCAN & iCANX (www.ican-x.com). Currently her research is focus on micro-nano devices, energy harvesting, self-powering smart system, etc.

KL-19

Silver Nanowire based Soft Electronics

Yong Zhu

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Abstract

Soft electronics takes a leap beyond Si-based rigid electronics. Soft electronic systems that are ultrathin, flexible and/or stretchable have broad applications from wearable health monitoring to next-generation robotics. Metallic nanowires, in particular silver nanowire (AgNWs), have emerged as a promising material for soft electronics. In this talk, I will discuss the recent advances in AgNW-based flexible, stretchable and wearable electronics. I will start with highly conductive and stretchable electrodes based on AgNWs, followed with development of a wide variety of wearable sensors for monitoring of human health and motions. I will highlight a critical issue for developing AgNW-based stretchable devices – scalable nanomanufacturing. Electronic waste has become a pressing issue that poses a threat to health and environment. Here I will propose a recycling approach to address the issue using AgNWs as an example. I will conclude my talk with some recent work extending from wearable sensors for human health to wearable plant sensors and soft robotics.

Biography

Yong Zhu holds the Andrew Adams Distinguished Professorship in the Department of Mechanical and Aerospace Engineering, with affiliate appointments in Biomedical Engineering and Materials Science and Engineering, at North Carolina State University. He received his BS degree from the University of Science and Technology of China and MS and PhD degrees from Northwestern University. After completing his postdoctoral training at the University of Texas at Austin he joined NC State University in 2007 as an Assistant Professor. His group conducts research at the intersection of mechanics of materials and micro/nano-technology, including nanomaterial-enabled stretchable and wearable electronics. His work has been recognized with a number of honors and awards including James R. Rice Medal from the Society of Engineering Science, Bessel Research Award from the Humboldt Foundation, and ASME Sia Nemat-Nasser Early Career Award and Gustus L. Larson Memorial Award.

ICFE 2021 International Conference on Flexible Electronics

The 3rd International Conference on Flexible Electronics

Nov. 13-14, 2021

Invited Lectures

(in alphabetical order)

IL-01

Modeling Programable Drug Delivery in Bioelectronics with Electrochemical Actuation

Raudel Avila

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Abstract

Drug delivery systems featuring electrochemical actuation represent an emerging class of biomedical technology with programmable volume/flowrate capabilities for localized delivery. Recent work establishes applications in neuroscience experiments involving small animals in the context of pharmacological response. However, for programmable delivery, the available flowrate control and delivery time models fail to consider key variables of the drug delivery system – microfluidic resistance and membrane stiffness. Here we establish an analytical model accounts for the key parameters – initial environmental pressure, initial volume, microfluidic resistance, flexible membrane, electrical current and temperature – to control the delivery using only 3 non-dimensional parameters and does not require numerical simulations allowing faster system optimization for different in vivo experiments. These results have relevance to the many emerging applications of programmable delivery in clinical studies within the neuroscience and broader biomedical communities.

Biography

Raudel Avila is a Ph.D. candidate in mechanical engineering at Northwestern University. He received a B.S. in mechanical engineering from the University of Texas at El Paso. His current research focuses on modeling the mechanics and electromagnetics in bio integrated electronics for health monitoring applications. As a PhD candidate, he has published more than 30 journal papers, many as lead author in high profile journals such as PNAS. He is currently a National Science Foundation GRFP Fellow and a Ford Foundation Predoctoral Fellow. He also received the Graduate Research Award from International Institute of Nanotechnology in 2019.

IL-02

Grinding Induced Subsurface Damage Study for Ultra-thin and Flexible Silicon Chips

Ying Chen

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Abstract

Inorganic semiconductors based flexible chips are the core for high-performance flexible electronic devices, especially in calculation and communication. There are several methods to make ultra-thin chips, including grinding, dry and wet etching, epitaxy based porous silicon and SOI wafer-based transfer printing, among which grinding is the widely used method to thin the IC wafers after the front-end fabrication by removing the backside substrate. However, grinding shall introduce damages in the hard and brittle silicon material, making the fabrication of good ultra-thin and flexible chips difficult and low-yield. To understand and diminish the damages caused by grinding process, subsurface damage (SSD) includes amorphization and dislocation is observed using transmission electron microscope (TEM). The SSD depth of chips under different processing parameter is predicted theoretically, which is in good agreement of experimental data. The increase of grit size, feed rate and decrease of wheel rotation speed is attributed to an increasing SSD depth. Three-point bending test is employed to measure the bending strength of ultra-thin chip processed by different grinding condition. The result show that increasing wheel rotation speed and decreasing grit size and feed rate will improve the bending strength of ultra-thin chip due to the reduction of SSD depth. Wet etching and chemical mechanical polishing (CMP) are applied respectively to remove SSD induced by grinding. Bending strength are both improved after wet etching and CMP for ultra-thin chip, but CMP offers higher bending strength than wet etching due to smoother surface profile. The study provides guidance not only for optimization of grinding process but also for manufacturing ultra-thin chips with higher bending strength.

Biography

Dr. Chen is currently an assistant researcher at Institute of Flexible Electronic Technology of THU at Zhejiang. She received her Ph.D. from Tsinghua University in 2017. She is also serving as Young Editor in journals including Acta Mechanica Sinica and Soft Science. Her research focuses on design and fabrication of flexible integrated electronics and flexible sensor. She has published more than 30 papers including those published on high-impact journals such as npj Flexible Electronics, ACS Nano, Journal of Applied Physics. She has been granted with 15 patents, including one PCT. Her research has been recognized by the First Prize of Natural Science Award from China Electronics Society (ranked 4th).

IL-03

Mechanical Properties of Bioinspired Materials and Their Applications in Flexible Electronics

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Abstract

Among different species of biomaterials, silk fibroin has attracted great attention due to its superior mechanical properties such as high stretchability, high strength, biocompatibility, as well as its biodegradability.[1] They can be made into various morphologies, for example hydrogels, sponges, films, etc., so as to facilitate their wide applications as medical textiles, surgical sutures, tissue engineering scaffolds, drug carriers, biosensors, etc.[2] Recently, great efforts are demanded in order to understand and further enhance the mechanical properties of silk fibroin based on molecular level. In this study, we have carried out largescale molecular dynamics simulations on different domains of silk protein. It was found that the mechanical properties of biomaterials could be tuned via tuning their structural properties or hybrid with nanomaterials. Targeted mechanical properties of bioinspired materials or their composites could be achieved by tuning the structural characteristics of these materials. These results provide in-depth understandings in molecular structure-mechanical property correlation in protein-nanomaterial interface, and will be providing a guideline to future design of bio-inspired materials for different applications including energy storage[3], wearable devices[2], etc.

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Biography

Dr. Yuan Cheng serves as the Associate Professor and President Assistant of Monash-SEU Joint Research Institute of Monash Suzhou campus. She received her Bachelor degree from the Department of Mechanics and Engineering Science, Fudan University, China in July 2003, and Ph.D degree from the Department of Mechanical Engineering, National University of Singapore in April 2008. Before join in Monash Suzhou, she worked at the Institute of High Performance Computing (IHPC) in Singapore from 2007 till Feb 2021 as Senior Scientist and Group Manager. During Feb. till Jun. 2009 she visited Brown University, USA as a visiting scholar. Dr. Yuan Cheng's research interest involve computational modeling and simulation of nanoscale assembly, as well as mechanical and physical properties of bio-inspired materials, exploring their applications in consumer care industry and wearable devices. She has published more than 80 journal papers in the leading journals including Prog. Polym. Sci., Adv. Mater., Nature. Comm., ACS Appl. Mater. Interfaces, J. Am. Chem. Soc., etc. with an H-index of 28. She has edited two books and has been serving as the Guest Editor of International Journal of Computational Methods, and Nanoscale Advances. She is elected as Fellow of International Association for Computational Mechanics.

IL-04

Organic Thin-film Transistors for Flexible Sensing Applications

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Abstract

Organic devices are promising candidates for next-generation smart products owing to their intrinsically light-weight, prominent flexibility, and potential for low-cost. Benefiting from studies on materials and device engineering, we reported a series of n-channel organic thin-film transistors with mobility over 1.0 cm^2 V^{-1} s^{-1}. Based on these devices, we fabricated varuiys sensing devices towards flexible applications.

Motiviated by the requirement to e-skin and advanced tactile perception system, we proposed the construction of flexible suspended gate OTFTs (SGOTFTs).[5] The SGOTFT provide an effective way to achieve ultra-sensitive pressure detection for various applications in health monitoring.[1-5] In addition, we developed an organic adaptive transistor (OAT) with sensory adaptation functionality by introducing a buried dynamic-trapping interface within the dielectric layer.[6] The device induces self-adaptive interfacial trapping to enable volatile shielding of the gating field, thereby leading to rapid and temporary carrier concentration decay in the conductive channel without diminishing the mobility upon a fixed voltage bias. More recently, we present an organic active adaptation transistor (OAAT) by introducing two bulk-heterojunctions (BHJs) into an organic transistor.[7] The coupling of the photovoltaic effect in two BHJs and dynamic electron trapping in the dielectric layer allows adaptive modulation of the carrier concentration. The device exhibits active photoadaptation behavior with light intensities ranging over 6 orders of magnitude and shown excellent autobackground control ability (<2 s@104 cd m^{-2}) comparable to those of human visual systems. This result pave a new way for smart organic transistors towards novel biomimetic electronics.

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Biography

Chong-an Di is a professor of Organic Solids Laboratory in the ICCAS. He finished his Ph.D. study in Chemistry from ICCAS, in 2008, and was appointed as a professor in 2016 at ICCAS. He used to work as an academic visitor in Cavendish Laboratory, Cambridge University and Senior academic visitor in Stanford University. Currently, his research focuses on the investigation of manipulating carrier transport and functional properties with organic semiconductors.

IL-05

3D Printing of Hydrogel-polymer Hybrids and Its Applications in Flexible Electronics

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Abstract

Hydrogel-polymer hybrids have been widely used for various applications such as biomedical devices and flexible electronics. However, the current technologies constrain the geometries of hydrogel-polymer hybrid to laminates consisting of hydrogel with silicone rubbers. This greatly limits functionality and performance of hydrogel-polymer based devices and machines. Here, we report a simple yet versatile multimaterial 3D printing approach to fabricate complex hybrid 3D structures consisting of highly stretchable and high-water-content acrylamide-PEGDA (AP) hydrogels covalently bonded with diverse UV curable polymers. The hybrid structures are printed on a self-built DLP based multimaterial 3D printer. We realize covalent bonding between AP hydrogel and other polymers by utilizing the incomplete polymerization of AP hydrogel initiated by the water-soluble photo-initiator TPO nanoparticles. We demonstrate a few applications taking advantage of this approach. The proposed approach paves a new way to realize multifunctional soft devices and machines by bonding hydrogel with other polymers in 3D forms.

Biography

Dr. Ge is currently a tenured associate professor at Southern University of Science and Technology (SUSTech), China. Before joining SUSTech, Dr. Ge was an assistant professor at Singapore University and Technology and Design (SUTD) from 2016-2019, where he was deeply involved in the founding and research activities of Digital Manufacturing and Design Centre (DManD). Dr. Ge received his Ph.D. from University of Colorado at Boulder (CU Boulder), United States, and after that, he conducted postdoctoral studies at CU Boulder, MIT and SUTD. Dr. Ge's research interests evolve from modelling and experiments on soft active materials (SAMs), to advanced manufacturing approaches of SAMs, development of high-performance and 3D printable SAMs, and now to their applications in soft robotics and flexible electronics. Dr. Ge has published more than 60 papers including the papers published on high-impact journals such as Science Advances, Nature communications, Advanced Materials, and Advanced Functional Materials. His collaborative works also appear on Science, Physics Review Letters, Advanced Energy Materials. Dr. Ge is recognized as one of the pioneers of the 4D printing technology and he published the first journal paper on 4D printing. Dr. Ge has received a few rewards including the National Talents Youth Program, IAAM Young Scientist Model, MINE2020 Outstanding Speaker, Outstanding Ph. D. Dissertation Award of CU Boulder.

IL-06

High Performance Electronic Skins and Their Applications in Robots/Human Body

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Abstract

An electronic skin (e-skin) can respond to applied pressure. Existing e-skins, however, often shows limited sensitivity and pressure resolution at elevated pressures, limiting their applications at high pressures. In this talk, I will introduce a strategy to engineer intrafillable microstructures that can significantly boost the sensitivity and pressure resolution while simultaneously broadening the pressure responding range. Such intrafillable microstructures feature undercuts and grooves that accommodate deformed surface microstructures, effectively enhancing the structural compressibility and the pressure-response range. Sensors with such microstructures present high pressure resolution (18 Pa) over a broad pressure regime (0.08 Pa-360 kPa). This talk will also introduce soft e-skins that have tough interlayer interfaces to achieve high robustness under complicated mechanical modes, and I will show that soft robots with such e-skins can precisely detect pressure distribution during manipulation tasks without any interfacial failure.

Biography

Dr. Guo is now a Professor of Materials Science and Engineering at the Southern University of Science and Technology (SUSTech). He received his bachelor's degree on Material Science and Engineering in the Huazhong University of Science and Technology (HUST), 2006. In 2011, he earned a PhD degree on Condensed Matter Physics from the Chinese Academy of Sciences. From 2011 to 2016, Dr. Guo worked as a postdoctoral fellow (research associate) at Boston College and the University of Houston. He joined SUSTech since 2016. His research focuses on flexible electronics, micro/nano fabrication, and soft robotics. Dr. Guo has published over 110 journal articles, including those published in Nature Materials, Nature Communications, PNAS, JACS, Advanced Materials, Nano Letters, ACS Nano etc. He has applied 38 patents and hold 17 granted inventions. His research progresses on flexible electronics have been reported by New York Times, Science Daily, Materials Today, and Physics Today.

IL-07

Transferable Inorganic Semiconductor Nanomembranes for Flexible/transient Sensors

Qinglei Guo

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Abstract

The rapid development of material science and semiconductor technology are promoting integrated circuits (ICs) into the post-Moore era, and a universal perspective holds that silicon is no longer suitable for extending the Moore's law. One of the most compelling opportunities for future directions of silicon involves the use of silicon, in an ultra-thin format, i.e., silicon nanomembranes, for constructing unusual devices or systems with features of large-area coverage, mechanically flexible, and/or physically transient. These unusual silicon-based electronics are normally named as flexible electronics, which strongly supports the developing route of "More-than-Moore". Specifically, silicon nanomembranes have practical appeal because of their unique physical properties and natural compatibility with current semiconductor technology, thus enabling the scalable manufacturing of various functionalized flexible electronic devices with capabilities of sensing, communicating, powering, or others. In this work, we will present our efforts on the developing advanced materials and assembly strategies for the construction of inorganic semiconductor-based flexible electronics, with emphases on the transfer of ultra-thin silicon/germanium nanomembranes and their applications in flexible/transient multifunctional sensors. We proposed a notch-assisted transfer technique to address the large-area assembly and controllable cracking of ultra-thin silicon nanomembranes. Then, flexible or stretchable electronic devices, including biosensors, photodetectors, dual-parameter sensors, and transient power supply devices will be fabricated and exhibited. These results will pave the way for the development of inorganic semiconductor-based flexible electronics, which strongly supports the developing route of "More-than-Moore" in the already arrived post-Moore era.

Biography

Qinglei Guo received his PhD in microelectronics and solid-state electronics from Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences. He is currently a professor in the School of Microelectronics at Shandong University (China). Before that, he worked as a post-doctoral researcher successively in Fudan University (China) and University of Illinois at Urbana-Champaign (USA). His research focuses on materials and devices for flexible/transient electronics. He has published more than 80 peer-reviewed journal papers.

IL-08

Flexible Photosensors Based on Organic Transistors

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Abstract

The growing demands of artificial intelligence, smart robotics, and human prosthetics urge for visual systems, pressure/mechano, and thermo/temperature sensors identical to biological sensory receptors.[1] Among these purposes, artificial visual systems are indispensable for night surveillance and medical imaging applications. For artificial visual system, photodetectors with organic semiconductors are very attractive due to the unique properties of band-gap designing, solution processable, intrinsic flexible and light weight, as well as low cost.[1]
we integrate three different organic semiconductors into one-pixel cell for ultrathin and high sensitive detectors. The magnification effect of organic transistors enhances ratio of light/dark current from 10^4 to 10^8.[2] Recently, we integrate a memory transistor in similar system. Featuring an integration of photosensing and floating-gate memory modules, the device possesses an acute color distinguishing capability. In general, the retina-like photosensor transduces NIR (850 nm) into nonvolatile memory and acts as a dynamic photoswitch under green light (550 nm). In doing this, a filter-free but color-distinguishing photosensor is demonstrated that selectively converts NIR optical signals into nonvolatile memory (Fig. 1).[3]
Very recently, we proposed a ferroelectric/ electrochemical modulated organic synapse, attaining three prototypes of plasticity: STP/LTP by electrochemical doping/de-doping and ferroelectric-LTP from dipole switching. The device supplements conventional electrochemical transistors with 10000-second-persistent non-volatile plasticity and unique threshold switching properties. As a proof of- concept for an artificial visual-perception system, an ultraflexible, light-triggered organic neuromorphic device (LOND) is constructed by this synapse. The LOND transduces incident light signals with different frequency, intensity, and wavelength into synaptic signals, both volatile and non-volatile (Fig. 2).[4]

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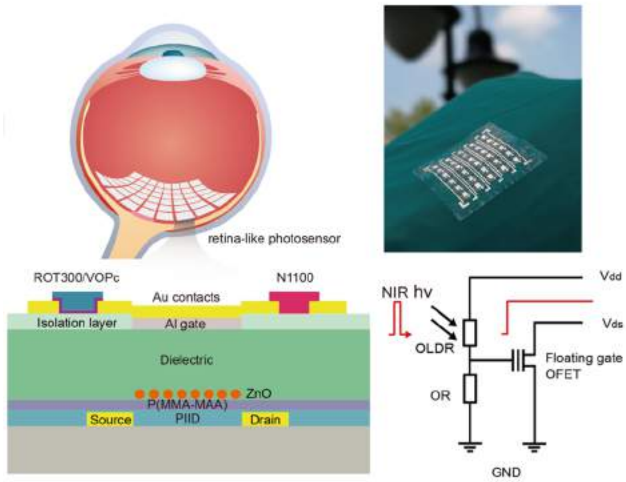

Figure 1. Organic retina-like photosensor system.

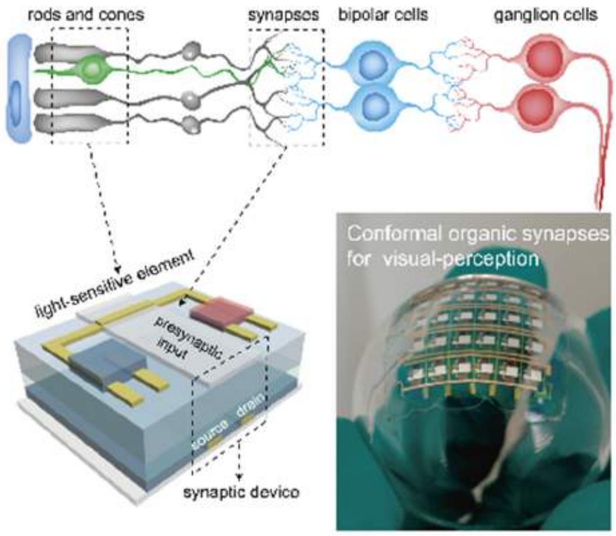

Fig. 2. Synapse based on organic electronics.

Biography

Yunlong Guo received his Ph.D. degree in physical chemistry from the Institute of Chemistry, Chinese Academy of Sciences (ICCAS), in 2010. From 2016, he is a project associate professor at the Department of Chemistry, The University of Tokyo. Presently, he is a professor at ICCAS. His research interests include organic–inorganic hybrid perovskite electronics and functional organic field-effect transistors.

IL-09

Soft, 3D Microsystems for Biomedicine

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Abstract

Commercial pressure sensors can achieve high-precision and high-resolution pressure detection, but their large volume and rigid structure cannot match with the soft between biological tissues, thereby limiting their applications in biomedicine. Pressure sensors based on novel soft materials, such as conductive polymers, have high sensitivity, but their intrinsic hysteresis affects the accuracy of pressure sensing. This talk will introduce a high-performance soft pressure sensor to address the above issues. In the aspect of structure design, the device exploits the traditional metal strain gauge, but with a three-dimensional configuration to realize the effective detection of normal pressure. In the aspect of application, this soft pressure sensor can integrate with wireless circuit module to realize the real-time, continuous monitoring of the pressure at the skin-prosthesis interface to prevent the skin damage caused by excessive pressure. Based on the same three-dimensional design, the metal strain gauge can be replaced by piezoelectric material for dynamic pressure sensing. In addition, the manufacturing process allows for constructing arrays of pressure sensors for spatiotemporal mapping.

Biography

Mengdi Han is an Assistant Professor of Biomedical Engineering at Peking University. He received his B.S. degree in Huazhong University of Science and Technology in 2012 and Ph.D. degree in Peking University in 2017. He was a visiting scholar at Department of Materials Science and Engineering, University of Illinois Urbana-Champaign from 2015 to 2017. He worked as a postdoctoral fellow at Querrey Simpson Institute for Bioelectronics, Northwestern University from 2017 to 2020. He published more than 80 SCI-indexed papers, including Nature Electronics, Nature Biomedical Engineering, Science Translational Medicine, Proceedings of the National Academy of Sciences, Nano Letters, ACS Nano, etc. He held 22 granted patents and wrote one book. His research interests include minimally invasive bioelectronics, non-invasive wearable electronics, and energy harvesting devices.

IL-10

Sensors Based on Conjugated Molecules

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Abstract

Conjugated molecules such as organic semiconductors and MOFs possess a unique combination of electric and environmental sensitive properties, and hence electronics based on conjugated molecules have been broadly investigated as sensors to transduce an environment changing event into an electric signal. In our work, various sensors, including temperature, optical and chemical sensors, were fabricated using different organic semiconductors or MOFs acting as the sensing materials. Interfacial effects were utilized to enhance the sensitivity. Selection of charge carriers can have impact to the sensing selectivity. Various strategies were developed to improve the sensing performance.

Biography

Dr. Jia Huang, Professor and Associate Dean, School of Materials Science and Engineering at Tongji University in Shanghai.

He got his B. Sc. in Materials Science and Engineering at University of Science and Technology of China, and Ph.D. in Materials Science and Engineering at Johns Hopkins University in USA. Currently Dr. Jia Huang's researches focus on organic semiconductors, flexible electronics, sensors, thin-film transistors, and synaptic devices. He was awarded the Chang Jiang Scholars Program in 2020.

IL-11

Flexible Electronics Based on Origami Magnetic Membranes

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Abstract

Magnetic membranes based on NdFeB rare earth materials have played an important role in the construction of new types of flexible electronic devices. Using the multiaxial folding and uniaxial magnetization technology, the arrangement of internal magnetic polarities can be edited to obtain complex magnetic field directions. These films not only can replace the permanent hard magnet array in the traditional rigid systems, but also can realize magnetic field enhancement basing on the edge effect, leading to the feasibility to use thin magnetic membranes in practical biomedical applications. The origami and magnetic field enhancement technology proposed by us has successfully been used to construct vibrational electromagnetic sensors, reconfigurable flexible circuits, flexible magnetic levitation centrifugal pumps, flexible self-expanding neural electrodes, wearable capturing devices for tumor cells, and different kinds of flexible robots. This presentation will talk about the preparation of magnetic films, approaches to edit magnetic fields, and design of surface structure design, and present the basic principles, design concepts, characterization methods, experimental results, and typical applications of various flexible electronic devices based on the magnetic films.

Biography

Xian Huang is currently a Professor at the School of Precision Instrument and Optoelectronics Engineering in Tianjin University. He received his Ph.D. degree in Mechanical Engineering from Columbia University in 2011, and worked as a Postdoctoral Researcher in the University of Illinois at Urbana Champaign from 2011 to 2014. He then worked as an Assistant Professor in the Department of Mechanical Engineering in Missouri University of Science and Technology before returning back to China in 2016. His major research area is flexible biomedical electronics, which includes devices for physical and chemical sensing and stimulation in wearable and implantable configurations as well as bioresorbable electronics. He developed flexible distributed multi-organ and multi-location measuring devices to realize distributed chemical and physical sensing and stimulation in tissues and organs. He also proposed a printing-based magnetoelectric composite devices and the technology to enhance magnetism of magnetic thin films, and promoted the miniaturization of large-scale medical systems through flexible magnetic devices. His invention of water sintering technology for bioresorbable and printable electronics overcame the environmental and energy requirements of traditional sintering technology, and greatly reduced the cost for manufacturing bioresorbable devices. He has published 70 journal papers and 16 conference papers with more than 6,000 citations, and has obtained 15 authorized patents.

IL-12

Flexible/elastic Sensitive Materials, Sensors and Smart Clothing Applications

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Abstract

Starting from the digital health care industry, aiming at the demand of intelligent clothing for information perception and information transmission, this talk introduces the challenges of existing rigid electronic devices and the advantages of flexible/elastic electronic devices. This talk will introduce the composite methods of liquid metal, magnetic materials and elastomer, and focus on the design, preparation methods and performance regulation of liquid metal based elastic conductor and tensile-stable elastic electrode. On this basis, the design, preparation and performance of elastic strain sensor, pressure sensor and bionic tactile/pain sensor are introduced, as well as their application cases in the fields of intelligent clothing and human-machine interaction.

Biography

Yiwei Liu, doctor, Professor of Ningbo Institute of materials, Chinese Academy of Sciences, founder/CEO of Ningbo Elas-Tech Co., Ltd. He is top young talents of Zhejiang WR program, top ten outstanding young people in Ningbo, members of youth Promotion Association of Chinese Academy of Sciences, etc. He has long been engaged in the application research of flexible/elastic sensitive materials, sensors and wearable devices. So far, he has published more than 50 SCI papers and authorized more than 30 invention patents. 10 patents have been transferred and transformed, and a science and technology start-up company has been incubated. The industrialization of elastic sensors with independent intellectual property rights has been realized. The company has been approved as a national high-tech enterprise. He also developed sports/health monitoring intelligent clothing and won the top ten new textile products Award in 2021. In addition, he also won honors such as the top ten scientific and technological progress in China's robot industry and the Gold Award in the national sports science and technology innovation competition, and was reported by CCTV.

IL-13

Flexible Electronic Systems with Silicon-Nanomembrane Transistor Array as Neural Interfaces

Enming Song

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Abstract

Flexible bioelectronic systems that establish active implants with long-term stability have been rapidly expanding impact in biomedical research as well as clinical practice, ranging from real-time monitoring to stimulation for bio-potentials. Here, this work focuses on the core content in soft electronic materials, ranging from thin-film inorganic bioelectronics, to high-performance semiconductor systems, to actively multiplexed device array for neural recording/monitoring, to their use as implantable bioelectronics: (1) microscale fabrication for over 32,000 silicon-nanomembrane (Si-NM) transistors as flexible interconnected network via transfer-printing technology, serving as neural electrophysiological mapping,; (2) development of thermally grown silicon dioxide nanomembrane as encapsulation layers at sub-micron thickness with operational stability over decades in-vivo; (3) establishment of implantable, biocompatible imaging techniques for brain signals for neuromodulation with capabilities of neural sensing and stimulation. Future efforts based on this work seek for advanced 3D neural interfaces with capabilities of stretchability and biocompatibility for in vivo multifunctional, high-performance electrical/optical neuromodulation, with great significance in monitoring/treatment for neurological disorders such as epilepsy.

Biography

Enming Song is currently an Associate Professor in Institute of Optoelectronics of Fudan University, started from 9/2021. He was a postdoctoral fellow in Simpson Querrey Institute (SQI) for Bioelectronics of Northwestern University from 2/2018/ to 10/2020 (Advisor: Prof. John A. Rogers), and was an Adjunct Research Assistant Professor in Frederick Seitz Materials Research Laboratory, University of Illinois at Urbana-Champaign from 3/2018 to 1/2019. His research interests refer to the fields of advance soft electronic materials for biomedical engineering, with a focus on developing flexible bioelectronic systems as chronic neural interfaces and of relevance semiconductor processing technologies. He has published 15 scientific papers as first/co-first author (10 of them as first author) such as Nature Materials, Cell, Nature Biomedical Engineering, 3 papers of PNAS, Advanced Materials, ACS Nano, 2 papers of Advanced Functional Materials, 2 papers of Advanced Electronic Materials, etc. His research was highlighted by journals such as Nature Materials, Nature Biomedical Engineering, JACS, and was highly recommended by scientific community. He also contributed 1 patent in USA in 2020.

IL-14

Stimulus-Driven Liquid Metal and Liquid Crystal Smart Actuators for Programmable Soft Robotics

Ling Wang

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Abstract

Bio-inspired soft-bodied robots engineered from responsive soft materials have recently attracted increasing attention from the perspective of both fundamental discoveries and promising technological applications.1-4 Compared to conventional rigid robots, soft robotics possess many attractive features such as structural deformability, human-friendly interaction, a high degree of freedom for actuation as well as environmental compliance and adaptability. Liquid crystal networks (LCNs) with anisotropic, reversible and programmable shape-morphing properties have been considered particularly promising for stimulus-driven soft actuators with diverse robotic motions, such as gripping, walking, swimming and oscillation, and intelligent functions including reconfigurability, self-regulation and associative learning.5-8 However, LCN-based soft robotic systems are often limited by their inadequate intrinsic thermal or electrical conductivity and mechanical incompatibility with functional nanomaterials. In this talk, I will demonstrate a general strategy to integrate electrically conductive liquid metals (LMs) and shape-morphing LCNs towards multifunctional and programmable soft robotics. As proof-of-concept demonstrations, I will present a light-fueled soft oscillator, an inchworm-inspired soft crawler and programmable robotic Shadow Play exhibiting multifunctional controllability. The strategy could open up a new technological arena for developing advanced multifunctional soft materials towards bioinspired soft machines, integrated soft electronics and beyond.

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Biography

Ling Wang is a full professor at School of Materials Science and Engineering of Tianjin University. He was an awardee of National Outstanding Young Talents and distinguished professor of PEIYANG Young Scholars of Tianjin University. He received his PhD degree of Materials Science from University of Science and Technology Beijing in 2013. He worked as a Postdoctoral Fellow at the Advanced Materials and Liquid Crystal Institute (USA), and Senior Research Fellow at the Artie McFerrin Department of Chemical Engineering of Texas A&M University (USA). His research interests focus on design, synthesis and properties of smart soft materials, bioinspired materials and functional nanomaterials, as well as their emerging applications in diverse fields ranging from soft robotics, adaptive camouflage to energy and safety issues (www.wanglinglab.com).

IL-15

Polarization-Sensitive Photodetectors based on 2D Layered Semiconductors

Zhongming Wei

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Abstract

Two dimensional (2D) materials have been attracting wide interest due to their peculiar structural properties and fascinating applications in the areas of electronics, optics, biology, and catalysis. As the promising substitutes for the gapless graphene, transition metal dichalcogenides (TMDCs, such as MoS2, WS2, etc.) which also have layered crystalline structure with strong in-plane bonding but weak interlayer action (van der Waals force) show natural band gaps. In our group, several 2D semiconductors and related alloys or heterostructures were successfully fabricated, and their optical properties and utilization in multifunctional optoelectronics were systematically investigated subsequently. Photodetectors with high polarization sensitivity are in great demand in advanced optical communication. Here, we demonstrate that photodetectors based on 2D layered GeSe, GeSe2 and GeAs, which are extremely sensitive to polarized light (from visible to the infrared), due to its reduced in-plane structural symmetry [1-4]. The polarimetric image sensor based on GeSe also showed high performance.

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Biography

Zhongming Wei received his B.S. from Wuhan University (China) in 2005, and Ph.D. from Institute of Chemistry, Chinese Academy of Sciences in 2010 under the supervision of Prof. Daoben Zhu and Prof. Wei Xu. From August 2010 to January 2015, he worked as a postdoctoral fellow and then Assistant Professor in Prof. Thomas Bjørnholm's group at University of Copenhagen, Denmark. Currently, he is working as a Professor at Institute of Semiconductors, Chinese Academy of Sciences. His research interests include low-dimensional semiconductors and their optoelectronic devices.

IL-16

Physical Intelligence of Bio-inspired Soft Robots

Li Wen

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Abstract

The interaction between robots and the natural environment attracts growing attention. Physical intelligence is a rising paradigm for rethinking how a robot interacts with an unknown environment. Soft robotics is a representative example of physical intelligence. In this report, I will introduce the octopus tentacle bioinspired robot and continuum soft manipulator project. Through the fundamental biomechanics principles, manufacturing soft robots, flexible sensing, this talk will elaborate on developing a soft robot into an autonomous and intelligent, interactive soft robot under the frame of physical intelligence.

Biography

Li Wen is a Professor and the head of the Mechatronics and Automation Institute, at Department of Mechanical Engineering, Beihang University. His current research interests include bio-robotics, soft robotics, and robotic intelligence. He published over 90 journal/conference papers including Science Robotics, Science Advances, IJRR, IEEE TRO etc. His representative work was featured by Nature, Science, MIT Technology review, and more. He was the recipient of the Chinese National Science Fund for Excellent Young Scholars in 2018, Steven Vogel Young Investigator Award, and Xiong Youlun Young Scientist Award in 2020. He leads several projects including the Chinese National Science Foundation, Key project etc. Li Wen served as an associate editor of Soft Robotics, editorial board member of Bioinspiration Biomimetics, associate editor of Journal of Bionic Engineering, etc.

IL-17

Transferring of Liquid Alloy Circuits onto Curved, Dynamic and Delicate Surfaces

Zhigang Wu

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Abstract

As a unique conductive material, room temperature liquid alloy has shown great potential for smart soft devices with superior softness, excellent electrical conductivity and high biocompatibility. However, with its extremely high surface energy, the transferring of liquid alloy onto various target surface, especially for curved/dynamic/organic/delicate surfaces, becomes challenging. In this talk, we will introduce our recent technical solution developments for the transferring liquid alloy circuits onto curved dynamic and delicate surface and discuss new possibilities for future possible applications. By tuning the surface morphologies induced surface energy change and utilizing the dynamic liquidity of liquid alloy, these techniques enable automatic transferring process and dynamical adaptation. Meanwhile, we also present a few demonstrations on delicate living organisms, including micro-heating on 1mm-scales living fruits flies and monitoring/manipulation for living plants. Such kinds of new applications may trigger new solutions of connecting living thing widely spread the ecologic system for a sustainable earth.

Biography

Zhigang Wu is a professor at Huazhong University of Science and Technology (HUST), China. Before joining HUST, Dr. Wu was an associate professor in Microsystems Technology, Uppsala University, Sweden. The mission of Wu's research is to develop new fabrication and manufacturing technologies for liquid fused soft intelligent systems that can potentially bring new solutions for societal challenges. Dr. Wu was selected as in junior researcher program by Swedish research council in 2010 and Chutian Scholar by Hubei government in 2012. Dr. Wu is the founding executive chair of International Symposium of Flexible and Stretchable Electronics and the chair of conference of Soft Robot Theory and Technology, 2019, Wuhan. He is also sitting the editorial board of J. Micromech. Microeng., and Micromachines.

IL-18

Minimally Invasive Devices for Biomedical Applications

Xi Xie

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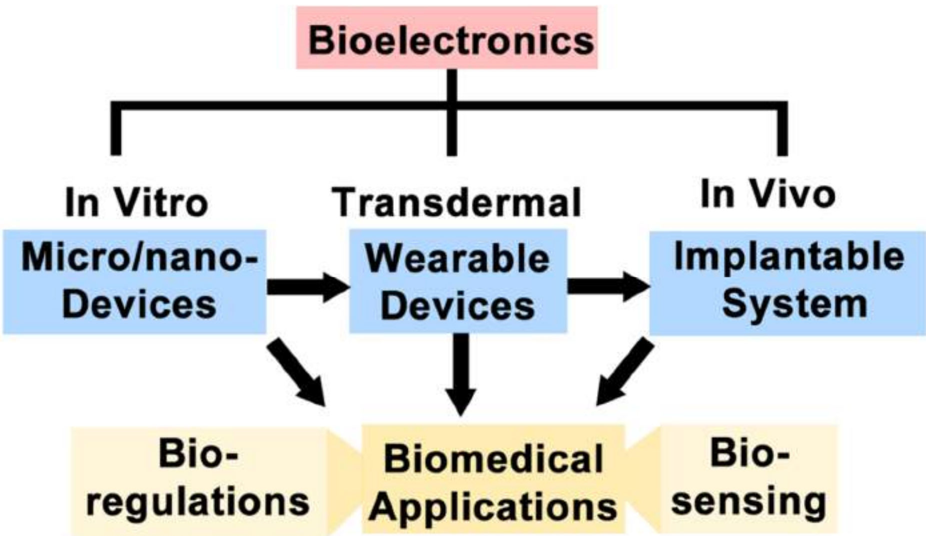
Abstract

Micro/nano system technology have greatly facilitate the development of bioinformatics research. In the field of bioelectronics and bioinformatics, researches have been greatly attracted by biological system modeling and disease predictions based on the understanding of intracellular protein dynamic expression. We have been focusing on the fundamental research on micro/nano-system for biomedical applications, trying to address the key issues on three levels, from the outside to the inside, in vitro – transdermal – and in vivo, aiming to overcome the key challenge of how to develop bio-safe technology to detect and regulate biological disease: 1) On the in vitro cellular level, we made breakthrough process on the development of nano-devices that could safely penetrate cell membrane, achieving regulation and sensing of the intracellular contents dynamically. 2) On the transdermal level, we systematically developed transdermal theranostic system, achieving precise and in situ detection and therapy of diseases. 3) On the in vivo level, we creatively develop bio-safe implantable theranostic system, achieving safe regulation and sensing of diseases in vivo. Our work holds great promise on facilitating the development of new tools for biomedical sensing detection and biomedical therapy, which would be critically important for the field of bioelectronics.



Biography

Prof. Xi Xie is currently a full professor in the School of Electronics and Information Technology at Sun Yat-sen University, and is an adjunct professor in the First Affiliated Hospital of Sun Yat-sen University at the meantime. He graduated from Stanford University in USA with PhD degree on 2014, and then worked as a postdoc researcher in the Prof. Robert Langer's lab at Massachusetts Institute of Technology. On 2016, he started his own research lab at Sun Yat-sen University. Prof. Xi Xie has been focusing on the fundamental research on micro/nano-system for biomedical applications. He has published 90 manuscripts. As corresponding author or first authors, 60 manuscripts have been published on journals including Nature Biomedical Engineering, Nature Nanotechnology, ACS Nano, Advanced Functional Materials and et al. These works were highlighted by Nature series journals for 3 times. He is also applying for more than 20 patents at the meantime. These works have been highlighted three times by Nature series journals. He was awarded by "MIT Technology Reviews Innovators Under 35 China", and won the "Outstanding Scientific Award of Chinese Institute of Electronics", and the "Microsystems & Nanoengineering Summit 2019 Young Scientist Award". He has applied for 38 patents, served as the editorial board member in two core journals including Life Science Instruments, and served as the academic members in three academic associations in China.

IL-19

Implantable Optoelectronic Devices for Advanced Neural Interfaces

Xing Sheng

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Abstract

Recent progresses in the design of mechanics and materials have given birth to flexible and stretchable electronics and photonics, enabling the integration of rigid inorganic devices with soft, elastic and curved biological systems. While current flexible photonic devices are mostly based on organic materials, bio-integrated high performance inorganic optoelectronic devices will provide new insights on interactions between light and bio-systems. Here we present unconventional strategies to design and fabricate thin-film, microscale optoelectronic devices and use them in implantable systems for biomedical applications. These devices are implanted deeply into the mouse brain, demonstrating close loop monitoring and manipulation of neural activity in vivo. Such an integrated, deeply implanted and microscale optoelectronic system provides new insights on interactions between optical signals and neural systems.

Biography

Xing Sheng is currently working as an associate professor in the Department of Electronic Engineering at Tsinghua University, China. He received his bachelor and PhD degrees from Tsinghua University and Massachusetts Institute of Technology, respectively. He worked as a postdoctoral researcher at University of Illinois Urbana-Champaign. His current interests are primarily in the exploration of implantable micro- and nano-scale optoelectronic devices, to enable high performance and versatile applications in biomedicine. He has published more than 50 papers in peer-reviewed journals. He is currently serving as an associate editor for OSA Optical Materials Express. He is the recipient of Young Scientist Awards in Progress in Electromagnetics Research Symposium (PIERS) and Microsystems & Nanoengineering Summit (MINE) in 2018.

IL-20

Curvature Tunes Wrinkling in Stretched Hyperelastic Films

Fan Xu

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Abstract

Transverse wrinkles usually occur in a uniaxially tensile elastic membrane and will be smoothed upon excess stretching. This instability-restabilization response (isola-center bifurcation) can originate from the nonlinear competition between stretching energy and bending energy. Here, we find a crucial factor, the curvature, which can control effectively and precisely the wrinkling and smoothing regimes. When the sheet is bent with curvature, the regime of wrinkling amplitude versus membrane elongation is narrowed, with local wrinkling instability coupled with global bending. There exists a critical curvature, where no wrinkles appear when the value is beyond this threshold. The curvature effects on wrinkling-smoothing behavior have been quantitatively explored by our theories, computations and experiments. The models developed in this work can describe large in-plane strains of soft shells to effectively capture this transition behavior, which build on general differential geometry and thus can be extended to arbitrary smooth surfaces with varying curvature such as torus. Our findings may shed light on rational designs of wrinkle-tunable membrane surfaces and structures for flexible electronics.

Biography

Dr. Fan Xu is a professor of solid mechanics at Fudan University (China). His current research interests include mechanics and physics of thin films, soft matters, biomaterials, metamaterials and 2D materials. He has published more than 40 papers in SCI journals such as Phys. Rev. Lett., J. Mech. Phys. Solids, Nature Biomed. Eng., Adv. Funct. Mater., Int. J. Solids Struct., Int. J. Eng. Sci., and Comput. Method. Appl. Mech. Eng. His research was highlighted by Nature, Nature Phys., Nature Comput. Sci., Nature Biomed. Eng., and selected as cover image by Phys. Rev. Lett. He received the National Science Fund for Excellent Young Scholars, ASME Prize (French section), and was selected as "Shanghai Shuguang Scholar" and "2018 Ten Emerging Star Scientists in China".

IL-21

Hybrid Laser Manufacturing of Multifunctional Flexible Sensors and System Integration

Kaichen Xu

School of Mechanical Engineering, Zhejiang University, China

Abstract

Sensors play crucial roles in the Internet of Things, artificial intelligence, and big data etc. In recent years, the development of flexible electronic manufacturing technologies has significantly extended the applications of smart sensors, which can be conformally attached onto the irregular surfaces. High-performance flexible sensors usually rely on judiciously engineering micro/nano-structures and active materials. Advanced laser manufacturing is endowed with versatile functionalities for flexible electronics. Based on the principles of laser-matter interactions, various novel flexible sensors have been developed to dynamically track pressure, temperature, humidity, slanting angles etc. Coupled with hybrid manufacturing technologies, this talk will also introduce a couple of integrated flexible sensing systems and their multifunctional applications.

Biography

Kaichen Xu is currently a ZJU-100 Professor at the School of Mechanical Engineering, Zhejiang University (ZJU). He is a key member of the State Key Laboratory of Fluid Power & Mechatronic Systems and senior member of Chinese Mechanical Engineering Society. He received the PhD degree from National University of Singapore (NUS) in 2018 and then moved to Osaka Prefecture University (OPU) as a JSPS Postdoctoral Fellow in Japan. His research mainly includes multifunctional flexible electrodes/sensors and systems' integration, advanced laser manufacturing. In the past five years, over 20 papers have been published in Adv. Mater., Adv. Funct. Mater., Adv. Sci., ACS Nano etc. including 16 papers as the first and corresponding authors. 2 articles were recognized as ESI Hot/Highly Cited Papers. He was invited to serve as a Corresponding Expert of Engineering, a journal launched by the Chinese Academy of Engineering and Editorial Board of Opto-Electronic Engineering. He is independent reviewers for over 30 journals (over 140 times).

IL-22

Artificial Synaptic Devices and Sensorimotor Nerves

Wentao Xu

Institute of Photoelectronic Thin Film Devices and Technology of Nankai University, Key Laboratory of Optoelectronic Thin Film Devices and Technology of Tianjin, College of Electronic Information and Optical Engineering, Nankai University, China(wentao@nankai.edu.cn)

Abstract

Neuromorphic electronics has received considerable attention for their applications in brain-inspired chips and artificially sensorimotor nerves. Recently, great efforts have been made in this research field. Here I will introduce our recent progress on design and fabrication of artificial synapses and their application in sensory and motor nerves.

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Biography

Wentao Xu received B.S. from Beijing Normal University and Ph.D. from Pohang University of Science and Technology (POSTECH). He has been a research associate professor at Seoul National University, and visiting scholar at Stanford University and University of Illinois at Urbana-Champaign. He is currently a professor in Nankai University, with main research interests in neuromorphic electronic devices, flexible electronics, electrohydrodynamic nanowire printing, memory devices, and thin-film transistors.

IL-23

Mid-infrared Communications based on Flexible Graphene Fibers

Yang Xu

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Abstract

Optical communications based on mid-infrared (MIR) light are vital in a wide variety of applications including imaging, security, environmental monitoring, metrology, and atmospheric science. Flexibility is the highly desirable feature of MIR communications where great challenges are still remained due to the limitations of both detectors and emitters. Here, we demonstrate that macroscopic graphene fibres (GFs) assembled from weakly-coupled graphene layers allow room temperature MIR detection and emission with megahertz modulation frequencies. The MIR detection and emission responses are correlated with photo-thermoelectric effect in millimeter-length and the ability to rapidly modulate gray-body radiation in GFs. Based on the dual-functionality of GFs, we set up a system that conducts bi-directional data transmission by switching modes between two identical GFs. The room-temperature operation of our systems and the potential to produce GFs on industrial textile scale offer opportunities for simplified and wearable optical communications.

Nature Communications, vol. 11, (1), pp. 6368-9, 2020.

Biography

Professor Yang Xu, Zhejiang University, PhD Supervisor, Professor of School of Micro-Nano Electronics, Professor of School of Information and Electronic Engineering, Professor of ZJU-UIUC Joint Institute, Scholar of Churchill College, University of Cambridge, UCLA Visiting Professor. His current research interests are focused on silicon-based micro-nano electronic devices and systems, silicon-based integrated brain-visual computing chips, silicon-based ultra-mole sensing chips. He has published more than 100 SCI journal papers including Nature Nanotechnology, Nature Photonics, Nature Comm, Adv. Mater., Phys. Rep., Chem. Soc. Rev., Nano Lett., ACS Nano, Phys. Rev. Lett., IEDM, with citations over 3000 times, and an H-index of 30. He holds 13 granted patents and gave more than 50 invited talks in MRS, ACS, APS, CPS, OSA, AIP, IOP, IEEE and Nature conferences. He also served as TPC and committee members of some IEEE, AIP, and IOP conferences.

IL-24

Soft Nanocomposite Materials for Flexible Electronics: From Self-assembly of Nanowires to in Situ Imaging of Microscopic Deformation

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Center of Soft Matter Physics and its Applications, Beihang University,
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Abstract

The emergence of flexible electronics demands novel soft functional materials. To this end, our research focuses on the design, processing, and mechanical behaviors of soft nanocomposite materials consisting of polymeric matrix and nanomaterials. In this talk, I will use two examples to show our work on this topic. In the first example, we use a shear flow to prepare silver nanowire networks with various degree of alignment. We established a relation among shear rates, degree of alignment, and electrical and optical anisotropy in silver nanowire networks. This work provides a new processing method for nanocomposites with anisotropic properties. In the second example, I will present our micro-mechanics techniques for measuring the distribution and evolution of stress and strain in soft materials, particularly at the interfaces between different materials. This experimental platform can provide insights of mechanical behaviors of soft materials at microscopic scale, which was not available using conventional mechanical testing methods.

Biography

Dr. Ye Xu is currently a professor in the School of Mechanical and Engineering at Beihang University in Beijing, China. He got his Ph.D. in Engineering and Applied Science from Yale University in 2012. From 2012 to 2015, he worked at a postdoctoral researcher in the Laboratory for Research on the Structure of Matter at the University of Pennsylvania. He then joined ExxonMobil's Corporate Strategic Research Lab and worked as a senior researcher in Engineering Physics, before moving to Beihang in 2017. He is now leading a multidisciplinary research group working on mechanics of soft materials, self-assembly of nanomaterials, protective coatings, and microfluidics for biomedical applications.

IL-25

Biodegradable Materials for Electronic Medicine and Biosensors

Lan Yin

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Abstract

Biodegradable electronics is a new category of devices that can be completely degradable in physiological environments and therefore eliminate secondary surgeries for device retrieval and minimize associated infection risks. These devices could play a critical role in many therapeutic and diagnostic processes, including promoting tissue regeneration, probing neurotransmitters, etc. Here, we propose novel materials strategies and fabrication schemes that enable a fully biodegradable and self-electrified conduit device for sciatic nerve regeneration. Successful nerve regrowth and motor functional recovery are achieved in rodents. In another example, real-time detection of nitric oxide in biological systems based on degradable materials integrating wireless modules is realized, which could offer essential information for monitoring inflammatory responses. These works provide new routes for modulating and probing important biological activities that can be beneficial for healthcare.

Biography

Lan Yin is currently an Associate Professor at Tsinghua University. She received her Bachelor's degree from Tsinghua University in 2007 and Ph.D. degree from Carnegie Mellon University in 2011, both in Materials Science and Engineering. She worked as a posdoctoral research associate in Massachusetts Institute of Technology in 2011-2012 and University of Illinois Urbana-Champaign in 2012-2015. In 2015, she joined School of Materials Science and Engineering at Tsinghua University with Thousand-Talent award. She has received the Excellent Young Scholar Award from the National Natural Science Foundation of China (NSFC) and is honored with the Chinese Materials Research Society (CMRS) the first prize of Science and Technology Award. Her research interests are focused on biodegradable materials and electronics, including biodegradable batteries, sensors, and therapeutic devices.

IL-26

Engineering of Carbon Materials toward Soft Electronics

Yingying Zhang

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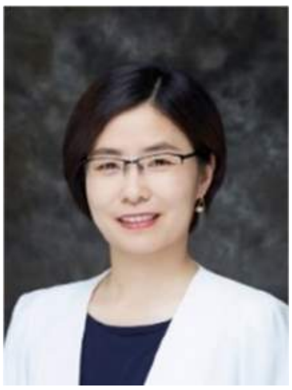
Abstract

Flexible and wearable electronics are attracting wide attention due to their potential applications in wearable human health monitoring and care systems. It is of great importance to explore low cost and scalable preparation approaches for high performance flexible electronics. Carbon materials have combined superiorities such as good electrical conductivity, intrinsic and structural flexibility, and light weight, enabling them to be promising candidate materials. In the past several years, we have been working on the rational design and controlled fabrication of flexible electronics based on carbon nanotubes, graphene, silk and their hybrid materials. We found that the hierarchical structure of the carbon materials plays important roles in achieving flexible devices with desired performance. At the same time, we have also explored the application of silk in flexible sensors by developing a carbonization strategy of silk nanofibers and fabric and by combing nanocarbons with natural silk materials. Based on the above, the applications of the obtained electronics in human health monitoring, human motion tracking, and human-machine interfaces have been demonstrated. These strategy provide new approaches for the low-cost production of high performance flexible and wearable electronics, which may promote the development of next generation smart electronics.

Biography



Yingying Zhang received her Ph.D. degree in physical chemistry from Peking University in 2007. Then, she worked in Los Alamos National Laboratory (USA) as a postdoctoral research associate. She joined Tsinghua University as an associate professor in July of 2011. Her research focuses on the design and controlled preparation of nanocarbon, silk, and their hybrid materials, aiming to develop high performance flexible electronics and wearable systems. She has authored more than 130 journal papers, including Nat Nanotechnol、Nat Commun、Sci Adv、Matter、Acc Chem Res、PNAS、Adv Mater、JACS etc, with more than 7000 citations. Besides, she has authored 1 book and 2 book chapters, and 16 awarded patents. She has been supported/awarded by National Science Fund for Excellent Young Scholar (2014), National Program for Support of Top-notch Young Professionals (2016), Young Scholars of Yangtze River scholar professor program (2017) and National Science Fund for Distinguished Young Scholars (2021).

IL-27

Long-Life-Cycle and Damage-Recovery Artificial Muscles via Controllable and Observable Self-Clearing Process

Huichan Zhao

Department of mechanical engineering, Tsinghua University, China(zhaohuichan@mail.tsinghua.edu.cn)

Abstract

Dielectric Elastomer Actuators (DEAs) exhibit a collection of excellent performances to be the next-generation artificial muscles, yet they suffer from short lifespan and premature breakdown. Self-clearing of defects from thin, compliant electrodes can potentially solve these problems, yet this process is currently neither observable nor controllable. In this work, we propose a dimensionless indicator named capacitor retention to indicate the remaining capacity to generate force/displacement of a DEA during self-clearing. Through self-clearing preprocess using appropriate combinations of factors derived from the above investigations, we achieve high-performance DEAs with unidirectional strain of 9%, power density of 300W, >1 million life cycle, and the ability to recover from multiple external damages. This work can potentially produce long-lifespan and highly robust artificial muscles for future mass applications of DEAs.

Biography

Huichan Zhao is an Associate Professor in the department of Mechanical Engineering, Tsinghua University. She got her Bachelor's Degree from Tsinghua University in 2012, and Ph.D. Degree from Cornell University in 2017. She was a post doc in the Harvard Microrobotics Lab from 2017 to 2018. Her main research interests include artificial muscles, stretchable sensors, and novel soft robotic applications. To date, she has published academic papers in Nature, Science Robotics, Nature Communications, PNAS, IEEE Transactions on Robotics, Advanced Functional Materials, IEEE Robotics and Automation Magazines, IEEE ICRA, IEEE Robotics and Automation Letters, etc. Her work has been cited for 1600+ times in Google Scholar, and three of her papers were selected as the ESI Highly Cited Papers in Web of Science. She has been selected as the DAMO Academy Young Fellow, Forbes China 30 under 30 in 2018, and MIT Technology Review Innovators Under 35 China in 2020. She served as the Associate Editor for IEEE Conference on Soft Robotics in 2019 and 2020. Currently, she is the Associate Editor for IEEE Transactions on Robotics.

Editors' Section
(in alphabetical order)

ES-01

Development of Science China Information Sciences

Jing Feng

Science China Information Sciences

Abstract

A brief report of Science China Press, the journal of Science China Information Sciences, and the journal's publications.

Biography

Dr. Jing FENG was born in 1974 and received her Ph.D. degree from Beijing Institute of Technology in 2015. Now, she is an Editor of Science China Information Sciences.

ES-02

Inside Nature Materials

Xin Li

Senior editor, Nature Materials

Abstract

This talk will present briefly the content related to flexible electronics in Nature Materials. The editorial process involved in publishing will also be introduced, including what editors do, what they look for, and how they make decisions, together with some practical tips for writing and submitting a paper to Nature Materials.

Biography

Xin Li received her first degree in materials science and engineering from Shanghai Jiao Tong University in China. She completed her PhD jointly at Georgia Institute of Technology and University of Lorraine, studying epitaxy growth and optoelectronic applications of wide bandgap semiconductors. She continued to work in the Georgia Tech-CNRS UMI as a postdoctoral researcher, and expanded her interests to 2D materials, nanostructures and flexible devices. At Nature Materials, which she joined in April 2017, Xin handles manuscripts in the areas of nanomaterials synthesis, structural materials and mechanical properties. Xin is based in the Shanghai office.

ES-03

Advancing Big Ideas with Small Science—How to Maximize Your Success!

Lu Shi

Wiley

Abstract

A highly competitive research environment with increasingly limited research funding has created a "Publish or Perish" attitude among scientists who are judged on both the quantity and the quality of their research articles. This presentation provides a brief overview of recent development of scientific publishing and peer review of manuscript that is handled by in-house editorial staff. Tips will be presented on some key strategies that could help the authors to get better results upon submitting their papers to the prestigious scientific journals. The presentation will also include an introduction to Advanced and Small family of journals and the most recently launched titles, including new open access flagship title on nanoscience and nanotechnology, Small Science.

Biography

Dr. Lu Shi received double Ph.D. degrees in Material Science and Condensed Matter Physics from the Catholic University of Louvain (Belgium) and the University of Grenoble Alps (France) in 2017 and obtained her B.Sc. at Shanghai Jiao Tong University and M.Sc. at the Shanghai Institute of Ceramics, Chinese Academy of Sciences. Her research interests are in the areas of 2D materials and heterostructures. She is now the Deputy Editor of Advanced Materials and Advanced Materials Interfaces, and works for Small Science, Advanced Electronic Materials, Advanced Sustainable Systems. She is based in Wiley Shanghai office.

ES-04

Publish in Science China, Report Global Advances in Science

Jie Yang

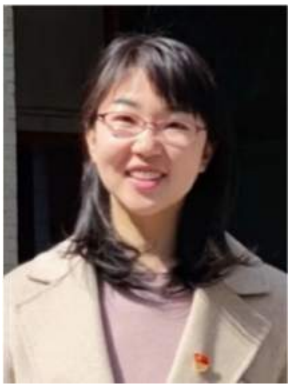
Science China Technological Sciences(yangjie@scichina.org)

Abstract

Science China Series of Journals were first published in 1950. They are currently co-sponsored by the Chinese Academy of Sciences and the National Natural Science Foundation of China. Dedicated to promoting intellectual exchange at home and abroad, these journals primarily report significant research results discovered by Chinese scientists.

As one of the journal in the Science China family，Science China Technological Sciences is committed to publishing high-quality, original results in both basic and applied research in the fields of engineering and materials sciences. This presentation will focus on the journal’s introduction, in-house editorial and peer review process, and the editor's insights.

Biography



Joined Science China Press from 2020 and is now working as the managing editor of Science China Technological Sciences, based in Beijing. Areas of responsibility include: energy sciences, nanoscience and technology, composite material, optical engineering, mechanics of materials, and metal materials Science.

The 3rd International Conference on Flexible Electronics

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