Zhejiang-Cambridge University Youth Scientist Forum

Zhejiang University, Hangzhou, China

2025.8.29-30

Organized By

浙江大學 信息与电子工程学院
COLLEGE OF INFORMATION SCIENCE & ELECTRONIC ENGINEERING
ZHEJIANG UNIVERSITY

Sponsored by

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Dear Scholars & Scientists;

We warmly welcome you to the **Zhejiang-Cambridge Youth Scientist Forum**, taking place August 29-30, 2025, at Zhejiang University's historic Yuquan Campus in Hangzhou, China. This collaborative event will gather outstanding early-career researchers from Zhejiang University (ZJU) and the University of Cambridge to engage in cross-disciplinary dialogue, fostering innovative solutions to global challenges at the intersection of science and technology.

Focused on the theme "Bridging Frontier for Tomorrow's Innovations", the forum will explore cutting-edge advancements across physical sciences, engineering, biomedical applications, nanotechnology, and materials science. There are **31 invited talks** and **10 Posters** delivered by doctoral candidates and postdoctoral scholars from both the institutions, showcasing their pioneering work in electronic materials, micro/nanodevices, bioelectronics, biotechnology, and related fields.

This event is designed to catalyze meaningful collaboration through interactive presentations, roundtable discussions, and networking opportunities with peers and experts. These interactions aim to inspire refined research directions, spark transnational partnerships, and highlight academic opportunities.

Zhejiang University, renowned for its vibrant culture, academic excellence and world-class facilities, looks forward to welcoming participants to an environment where ideas converge and partnerships thrive. We encourage you to seize this opportunity to build professional networks and lay the groundwork for future collaborations, and position yourself for future academic roles within Zhejiang University.

We eagerly anticipate your participation in this dynamic exchange of knowledge and vision.

Yours sincerely

Prof. Jikui Luo & Prof. Zongyin Yang

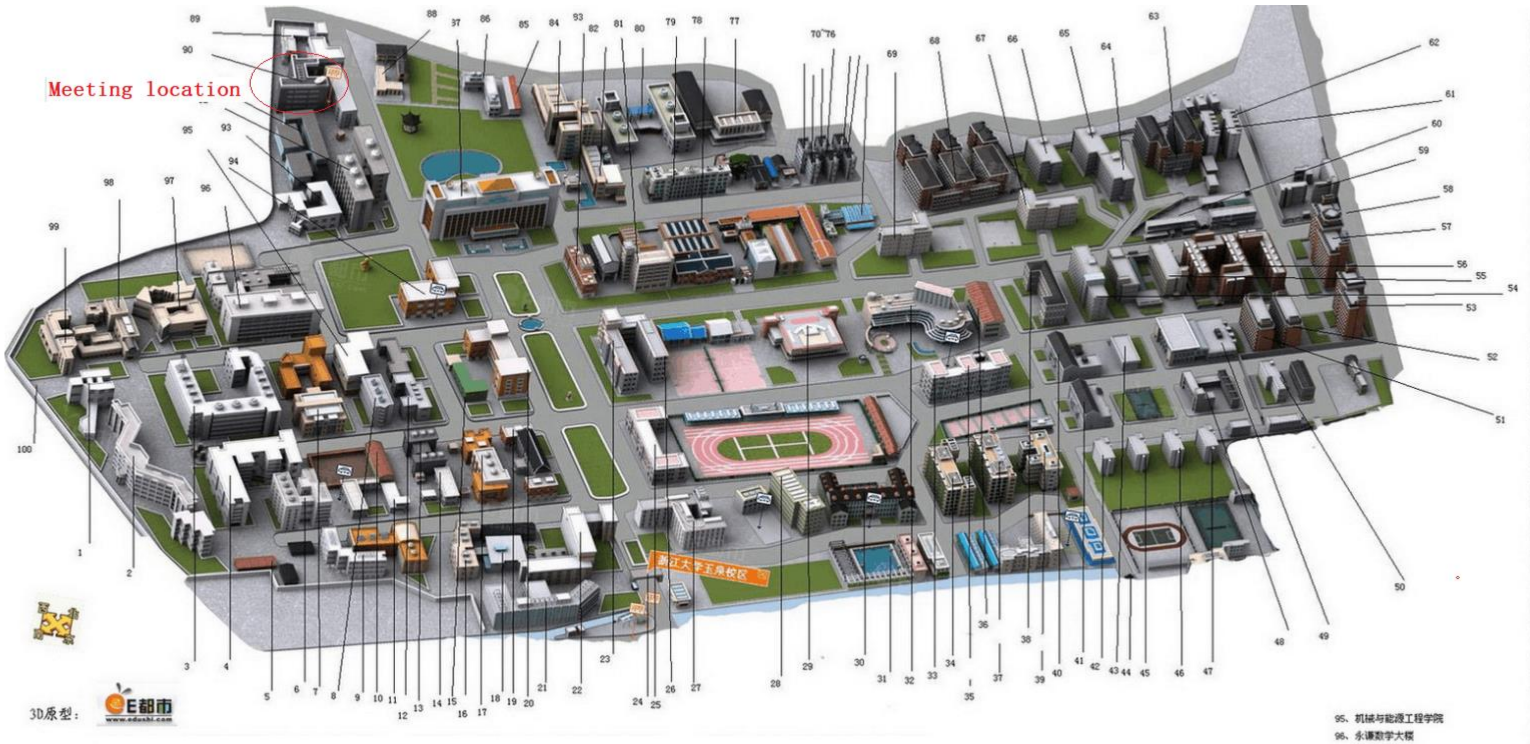
College of Info. Sci. & Electron. Eng.,

Zhejiang University

Location：

Yuquan Campus, Zhejiang University, No. 38, Zheda Road, Hangzhou, Zhejiang.

（中国浙江省杭州市西湖区浙大路 38 号）



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07、周亦卿科技大楼
08、李达三能源楼
09、书店公司
10、同力驾陪中心
11、动力机械及车辆工程研究所
12、联合化学反应工程研究所
13、工业电子技术实验楼
14、电力系统动态模拟实验室
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43、浙大浴室
44、新桥门
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47、19舍
48、后勤印刷厂
49、四食堂/二食堂
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96、永谦数学大楼
97、邵逸夫科技馆
98、欧阳纯美科学楼
99、邵逸夫工商管理楼
100、南校门

Presentation & Poster Program

August 28th

15:00-17:30 **Registration: Building for College of Polymer Science & Engineering**
（高分子楼 1 楼大厅）

August 29th

8:30-9:45 **Registration:**高分子楼 1 楼大厅

9:45-10:00 **Opening Ceremony**

Presentation sessions

Bioelectronics

Session Chair: **Jikui Luo**

10:00-10:20	A1	Muzi Xu	Biomimetic Strain Sensor System for Omnidirectional Biophysical Signals Monitoring and Analysis
10:20:10:40	A2	Jie Xia	A Wearable EEG-fNIRS System for Synchronous Recording of Neural Activity and Hemodynamics
10:40-11:00	A3	Fan Zhang	Transparent neural electrode reveals polarity-dependent responses of cortical neurons to direct current stimulation
11:00:11:20	A4	Yuan Shui	Imperceptible Augmentation of Living Systems with Organic Bioelectronic Fibres
11:20-11:40	A5	Hao Wen	Passive flexible wearable sensing device based on printed radio frequency antenna
11:40:12:00	A6	Jie Li	Enhanced Wireless Passive Sensing System Based on Parity-Time Symmetry and Iontronics
12:00-13:00	**Lunch time**		
Session Chair:	**Zhen Cao**		
13:00-13:20	B1	Marco Vinicio Alban	Multi-analyte Multimodal Sweat Analysis: Organic Electrochemical Transistor Integration for Continuous Health and Fitness Monitoring

13:20-13:40	B2	Xin Huang	A Comprehensive Multimodal Emotion Dataset: Enhancing Valence-Arousal Representation and Personalized Emotion Recognition
13:40-14:00	B3	Shengming Wang	Thermo-Responsive Biphasic Wrapping Electrode for Continuous Intraoperative Neurophysiological Injury Monitoring
14:00-14:20	B4	Suhao Wang	Mechanically Adaptive and Deployable Intracortical Probes Enable Long-term Neural Electrophysiological Recordings
14:20-14:40	B5	Hang Liu	Bone Fracture Healing under the Intervention of a Stretchable Ultrasound Array
14:40-15:00	B6	Kaihang Zhang	Nanogenerators Based Self-Powered Wearable and Implantable Devices
15:00-15:30	**Coffee Break**		
Session Chair:	**Shurong Dong**		
15:30-15:50	B7	Guolin Yun	Multiscale structured liquid metal elastomers for 3D force sensing array
15:50-16:10	B8	Yanhua Song	Polymer-Based Wearable Flexible Pressure Sensors for Human Health Monitoring
16:10-16:30	B9	Yunrui Cao	Researches on biochemical sensing detection based on upconversion nanoparticles (UCNPs)
16:30-16:50	B10	Boyu Li	Octopus-inspired Gradient Adsorption Patch for Stable Electrophysiological Monitoring
16:50:17:10	B11	Yingjie Tang	Flexible Active-Matrix Sensing Systems Based on Metal Oxide Thin-Film Transistors
17:10-17:30	B12	Xuefeng Xu	Label-Free Acoustoelectric Platform for Tumor Cell Isolation and Multimodal Analysis
18:00-20:00	**Dinner：Lingfeng Hotel （灵峰山庄酒店）**		

August 30th

Materials & Devices

Session Chair:	**Xiaozhi Wang**		
8:30-8:50	C1	Binghan Zhou	Generalising Murray’s Law for Materials
8:50-9:10	C2	Yutong Wang	Moiré cavity quantum electrodynamics

9:10-9:30	C3	Zheng Gong	Free-electron resonance transition radiation from periodic and aperiodic multilayers
9:30-9:50	C4	Fujia Chen	Magnetic topological photonic crystals
9:50-10:10	C5	Yinpeng Chen	Laser-induced full-color printing with water-processable phase-changing material
10:10-10:30	**Coffee Break**		
Session Chair:	**Zongyin Yang**		
10:30:11:00	C6	Wenqian Yao	Wafer-sized deposition thin films for high-mobility transistors and single-photon detectors
11:00-11:20	C7	Osarenkhoe Ogbeide	Fractal-Inspired Inkjet-Printed Gas Sensor Arrays for Room Temperature Formaldehyde Detection
11:20-11:50	C8	Yaqi Shi	Dynamic Multi-FSR Encoding for Computational Hyperspectral Imaging
11:50-12:10	C9	Ruqiao Xia	Frequency-Tunable Terahertz Modulators Enabled by Graphene Brickwork Metamaterials
12:10-13:30	**Lunch time**		
Session Chair:	**Hao Jin**		
13:30-13:50	D1	Petros Symeon	High-Responsivity CVD-Grown hBN/Graphene Bolometers Operating in the C-Band
13:50-14:10	D2	Xiangyu Zen	Weyl-semimetal-based Negative Quantum Capacitance Effect for the Steep-Slope logic Device
14:10-14:30	D3	Chenyu Wang	Threshold-Voltage Tuning in ZnO Thin-Film Transistors: Process Development and Circuit-Level Applications
14:30-14:50	D4	Wenwei Gao	Highly Linear and Compact Thin-Film Lamb Wave Resonator with Self-Aligned Micro-Magnet for Contactless DC Current Sensing
14:40-15:00	**Coffee Break**		
15:00-16:00	**Discussion on special topics**		
16:00-18:00	**Lab. & Campus Visiting**		
18:30-20:00	**Dinner：Lingfeng Hotel** （灵峰山庄酒店）		

Posters

P1	Jiaqi Lu	Magnetized GO/NdFeB–PDMS Composites for Magnetoelastic Generators in Wearable and Ultrasound Energy Harvesting
P2	Shicong Gui	A Novel Wireless Neural Stimulator with Simultaneous Energy-Information Transmission
P3	Luxi Zhang	Monolithic Multimodal Neural Probes for Sustained Stimulation and Long-term Neural Recording
P4	Dinku Hazarika	Ion dipole interaction and directional alignment enabled high piezoelectric property polyvinylidene fluoride for flexible electronics
P5	Yeping Yin	A Process Design Kit for Integrated Circuits Based on Zinc Oxide Thin-Film Transistor Technology
P6	Xueqian Zhang	Regulation of Spatiotemporal Distribution of ROS by Fascia Based on Mechanoelectrochemical Coupling Mechanisms
P7	Houbin Sun	Label-free Microfluidic Impedance Flow Cytometry Coupled with Deep Neural Network for Single-Cell Cancer Classification
P8	Yifan Li	Rapid and Sensitive Cancer Biomarker Detection Using Flow-through Immunoassays with Integrated Au Nanorod Arrays
P9	Rui Wan	Reversible Exciton Modulation in Monolayer MoS_2 via Acoustic Control of Oxygen Physisorption
P10	Yinpeng Chen	Laser-induced full-color printing with water-processable phase-changing material

A1

Biomimetic Strain Sensor System for Omnidirectional Biophysical Signals Monitoring and Analysis

Muzi Xu[1], and Luigi G. Occhipinti*[1]

[1]*Electrical Engineering Division, Department of Engineering, University of Cambridge; Cambridge, CB3 0FA, UK.*

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Abstract: Omnidirectional flexible and stretchable strain sensors play a vital role in addressing the complex, dynamic, and variable conditions of real-world scenarios such as healthcare monitoring, human motion tracking, and human-machine interfaces(*1*). To date, two main strategies have been adopted to realize omnidirectional strain sensing: single-sensor system(*2*) and multi-sensor system(*3*). These approaches have mainly focused on achieving either isotropic omnidirectional sensing or strain direction recognition—two critical yet fundamentally conflicting capabilities. This conflict arises from a core technical contradiction: isotropic sensing requires a mechanically homogeneous platform that produces uniform responses regardless of direction, whereas direction recognition depends on anisotropic signal variations to differentiate orientation. As a result, integrating both functionalities into a single sensor remains a substantial challenge.

To overcome this limitation, in our recent work(*4*), we drew inspiration from the human finger, renowned for its hypersensitive and omnidirectional tactile perception, and developed the IOHSDR sensor, which uniquely enables simultaneous isotropic omnidirectional strain sensing and direction recognition within a single device. This advancement was achieved through the design of a heterogeneous substrate incorporating an involute of a circle architecture, which imparts isotropic mechanical behaviour along the radial direction while maintaining anisotropic features along the involute path. This structural design allows for both high strain sensitivity and directional signal differentiation.

Supported by a bespoke deep learning framework, the IOHSDR sensor demonstrates outstanding performance, achieving 99.58% accuracy in recognizing 360° stretching directions. Furthermore, successful application demonstrations, such as radial artery pulse and throat vibration monitoring, highlight the device's unique combination of isotropic sensitivity and precise direction recognition. This innovative omnidirectional sensing system establishes a new paradigm for high-fidelity biophysical signals acquisition and paves the way for advanced wearable technologies in health monitoring and disease diagnostics.

References:

1. T. Q. Trung, N.-E. Lee, Flexible and Stretchable Physical Sensor Integrated Platforms for Wearable Human-Activity Monitoringand Personal Healthcare. *Advanced Materials* **28**, 4338–4372 (2016).

2. L. Liu, S. Niu, J. Zhang, Z. Mu, J. Li, B. Li, X. Meng, C. Zhang, Y. Wang, T. Hou, Z. Han, S. Yang, L. Ren, Bioinspired, Omnidirectional, and Hypersensitive Flexible Strain Sensors. *Advanced Materials* **34**, 2200823 (2022).
3. J. H. Lee, S. H. Kim, J. S. Heo, J. Y. Kwak, C. W. Park, I. Kim, M. Lee, H.-H. Park, Y.-H. Kim, S. J. Lee, S. K. Park, Heterogeneous Structure Omnidirectional Strain Sensor Arrays With Cognitively Learned Neural Networks. *Advanced Materials* **35**, 2208184 (2023).
4. M. Xu, J. Zhang, C. Dong, C. Tang, F. Hu, G. G. Malliaras, L. G. Occhipinti, Simultaneous Isotropic Omnidirectional Hypersensitive Strain Sensing and Deep Learning-Assisted Direction Recognition in a Biomimetic Stretchable Device. *Advanced Materials* **37**, 2420322 (2025).

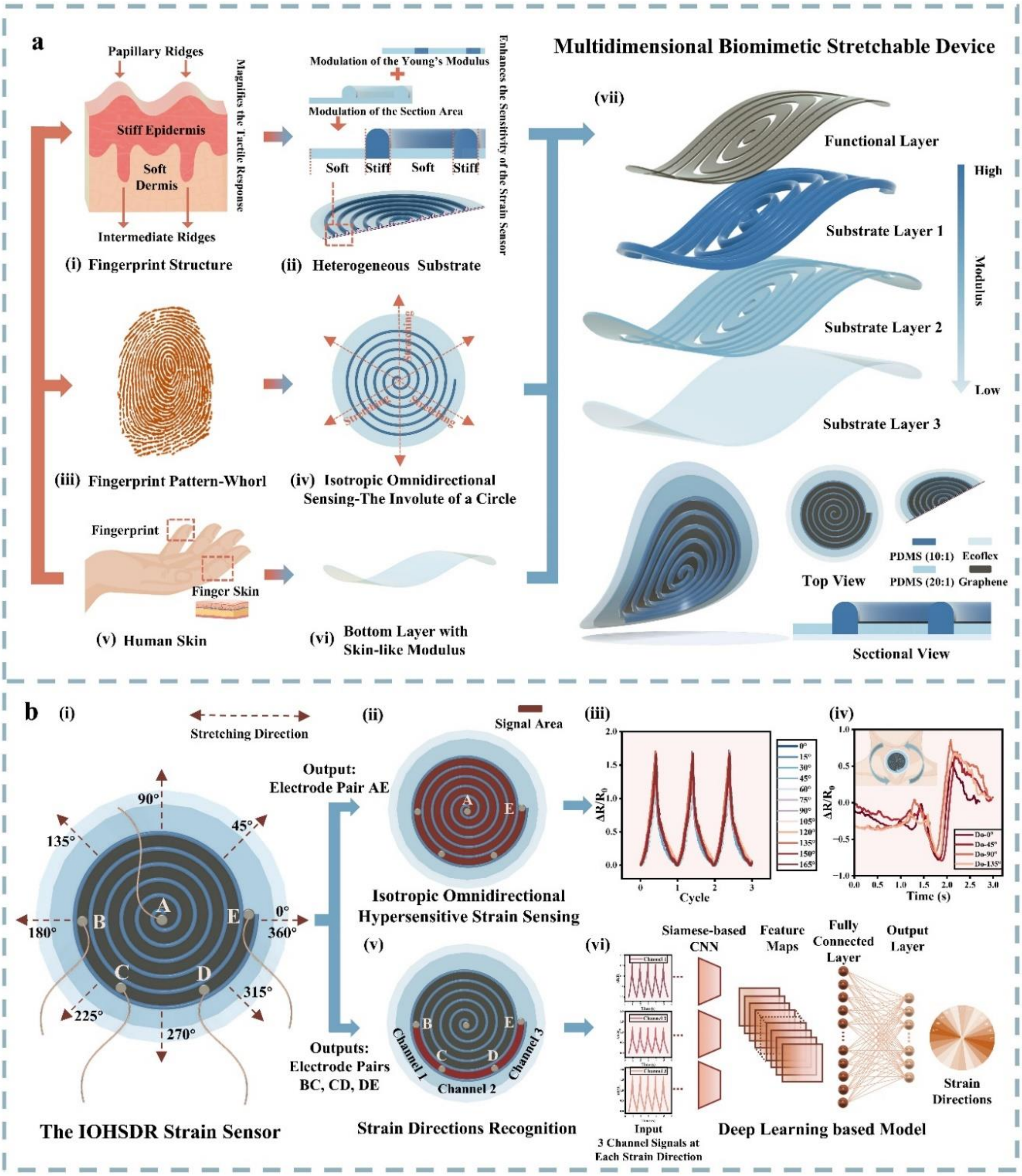

Figure.1 Schematic illustrations of the IOHSDR (isotropic omnidirectional hypersensitive sensing and direction recognition) strain sensor system. (4)

A2

A Wearable EEG-fNIRS System for Synchronous Recording of Neural Activity and Hemodynamics

Jie Xia[1,2], Jiadong Pan[1,2], Boyu Li[1], Zilong Ye[1], Shurong Dong[1,2]*

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[2] Hangzhou Rongnao Technology Co., Ltd., Building 23, Suite 506, No. 68 Jiangnan Road, Chunjiang Sub-district, Fuyang District, Hangzhou, Zhejiang, China

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Abstract: This paper presents a fully integrated, wearable EEG-fNIRS headpiece that concurrently acquires high-fidelity cortical electrical signals and hemodynamic responses through dry-contact electrodes and dual-wavelength (760 nm/850 nm) optodes. By co-designing the Texas Instruments ADS1299 EEG controller and AFE4404 fNIRS front-end on a single low-noise analog board, the system achieves synchronous 24-bit digitisation with EEG input-referred noise $\leq$0.9 µVrms, amplitude distortion <2 % and frequency distortion <1 % even when LEDs are active, while embedded motion-artifact suppression and active shielding further enhance data quality. Mechanical optimisation yields a detachable, sub-35 g module, eliminating the spatial misalignment and timing jitter that plague multi-device assemblies. Validation proceeds in two steps: (i) a forearm cuff occlusion demonstrates robust $\Delta HbO_2/\Delta HbR$ modulation confirming optical sensitivity; (ii) a prefrontal Stroop task with co-located EEG electrodes at Fp1/Fp2 and eight surrounding fNIRS detectors reveals congruent neurovascular dynamics—ERP components P450, N500 and P600 are reliably elicited. The shared clock architecture guarantees sub-millisecond synchrony, and Bluetooth Low Energy streaming enables tether-free operation for naturalistic or hyperscanning paradigms. Collectively, the work establishes an ergonomic, clinically viable platform for multimodal brain research, closed-loop brain–computer interfaces and large-scale social neuroscience studies.

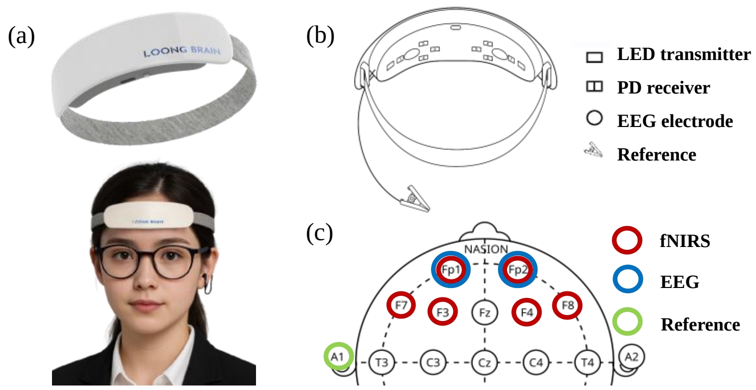

Fig.1 *(a)Device appearance; (b) The overall system architecture; (c) The layout of EEG and fNIRS sensors.*

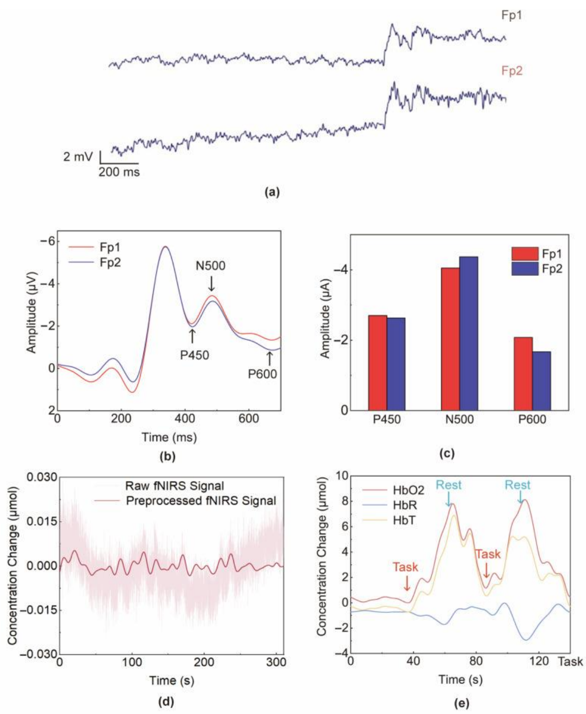

Fig. 2 *(a) Raw EEG data of Fp1 and Fp2; (b) ERP results in a trial; (c) average amplitude of three ERP components in Fp1 and Fp2; (d) comparison of original fNIRS signal and preprocessed fNIRS signal; (e) the ΔHbO2, ΔHbR, and ΔHbT values of the brain Fp1 point in the Stroop task.*

A3

Transparent neural electrode reveals polarity-dependent responses of cortical neurons to direct current stimulation

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[1]*Key Laboratory of Biomedical Engineering of Ministry of Education, Qiushi Academy for Advanced Studies, State Key Laboratory of Brain-Machine Intelligence, Zhejiang University*

[2]*School of Life Sciences, Westlake University*

[3]*Department of Neurosurgery, Second Affiliated Hospital, School of Medicine, Zhejiang University*

[4]*Westlake Institute for Optoelectronics, Westlake University*

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Abstract: Transcranial direct current stimulation (tDCS) is widely applied for cognitive enhancement, neurorehabilitation, and mental health interventions, yet its precise effects and neural mechanisms remain unclear, limiting protocol optimization and clinical translation. To address this, we designed and fabricated a novel transparent neural electrical stimulation electrode and combined it with in-situ two-photon calcium imaging to investigate the effects of anodal versus cathodal DC stimulation on mouse cortical neurons. First, leveraging indium tin oxide and micro-nano fabrication techniques, we produced a transparent electrode with over 80% transmittance across the visible spectrum and excellent electrical conductivity, compatible with high-resolution optical imaging and efficient electrical stimulation. The electrode conforms snugly to the mouse cortex and reliably delivers charge at a current density of 1.59 mA/cm² for 30 s under both anodal and cathodal polarities, without measurable degradation in its electrical or optical performance. Using this electrode in awake mice, we performed real-time two-photon calcium imaging of layer 2/3 cortical neurons and the surrounding neuropil during both polarities of DC stimulation. Anodal stimulation produced a significant increase in neuronal calcium signals, indicating predominantly excitatory activation, whereas cathodal stimulation induced a clear suppression of calcium activity. Notably, the neuropil calcium signals exhibited the same acute, polarity-dependent trends as neuronal somata but with heightened sensitivity to polarity changes, suggesting that DC stimulation may engage additional biophysical mechanisms beyond simple membrane polarization. This study provides the direct visualization of the differential effects of anodal

and cathodal DC stimulation on cortical neuronal activity via a transparent electrode, offering new experimental evidence to elucidate tDCS mechanisms and inform the optimization of clinical intervention strategies.

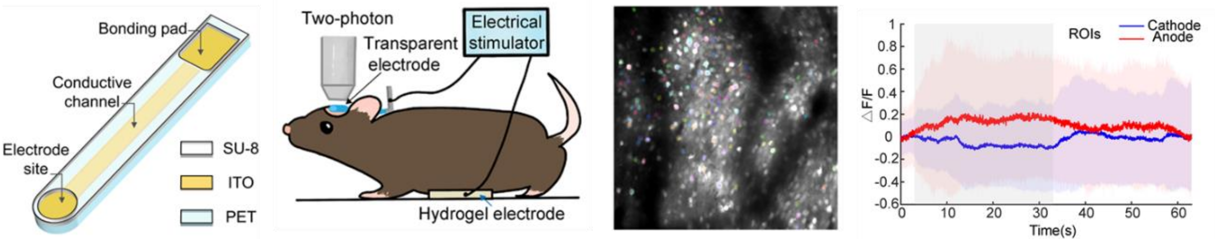

Fig. 1 Visualization of DC stimulation effects via a transparent electrode. Left: Indium-tin-oxide transparent neural electrode on the awake mouse cortex, enabling in situ two-photon calcium imaging through > 80 % light transmittance. Right: Layer 2/3 calcium-signal maps and traces showing excitation under anodal stimulation and inhibition under cathodal stimulation.

A4

Imperceptible Augmentation of Living Systems with Organic Bioelectronic Fibres

Wenyu Wang[1,2], Yifei Pan[1,2] , Yuan Shui[1,2], Tawfique Hasan [3], Iek Man Lei[4], Stanley Gong Sheng Ka[1,2], Thierry Savin[1], Santiago Velasco-Bosom[1], Yang Cao[1,2], Susannah B. P. McLaren[5,6], Yuze Cao[1,2], Fengzhu Xiong [5,6], George G. Malliaras[1] & Yan Yan Shery Huang[1]

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The integration of electronics with biological systems offers tremendous potential for health monitoring, environmental sensing, and wearable technologies. However, conventional electronic interfaces often involve energy-intensive fabrication processes and tend to disrupt natural sensations or compromise biocompatibility to satisfy functional performance. This work introduces an in-situ orbital spinning technique that enables the direct deposition of ultrathin organic bioelectronic fibres onto living subjects such as human skin, embryos, and plants with imperceptible interference.

These substrate-free fibres, composed of PEDOT:PSS-based composites, form open and conformal networks that adapt intimately to complex biological topographies while maintaining mechanical resilience and multi-sensing capabilities. It develops on-skin applications such as ECG/EMG recording, touch-sensitive dual-person sensing, and skin-gated organic electrochemical transistors (OECTs). The fibres also support reconfigurable circuit design, interfacing with microelectronics and e-textiles, and are repairable and recyclable which addressing sustainability concerns in bioelectronics.

Overall, this platform provides a material and energy-efficient approach to bioaugmentation that is both mechanically imperceptible and environmentally conscious. This work paves the way for adaptive, modular, and sustainable electronic systems integrated seamlessly with life.

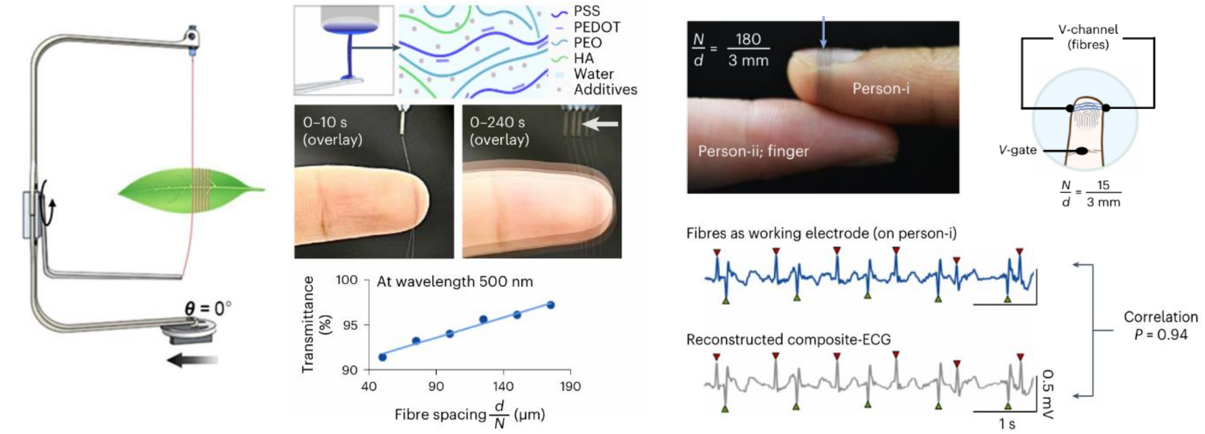

Fig.1 Imperceptible fiber tethering on fingertip induces augmented touch perception via dual ECG sensing

A5

Passive flexible wearable sensing device based on printed radio frequency antenna

Hao Wen[1], Feiyang Huang[1], Kailong Dong[1], Zhiqing Gao[1], Xin Li[1], Qingjun Liu[1*]

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Abstract: Flexible wearable sensing devices hold great application potential in the field of health monitoring, and the passive and miniaturized design of such devices can enhance both sensing performance and wearing comfort. This report employs low-cost printing techniques such as 3D printing, aerosol jet printing, and blade coating to fabricate printed radio frequency (RF) antennas and integrate sensitive components, thereby constructing a passive, skin-friendly, multimodal sensing and detection system. Based on the characteristics of biomarkers such as sweat, proteins, and finger movements, corresponding sensitive components are developed. Inductive coils are utilized to construct resonators with filtering capabilities, while the internal structure and macroscopic dimensions of the sensitive components are optimized to improve quality factor and selectivity. Changes in parameters such as thickness and dielectric constant, which occur when the sensitive components interact with biomarkers, are converted into variations in RF resonant signals and transmitted to external receiving terminals. Compared to traditional methods, this work develops a multimodal sensor array that eliminates the need for Bluetooth, batteries, or complex integrated circuits, achieving high-precision acquisition of physiological parameters and activities. It provides a novel technical solution for in vitro diagnostics and human-machine interaction.

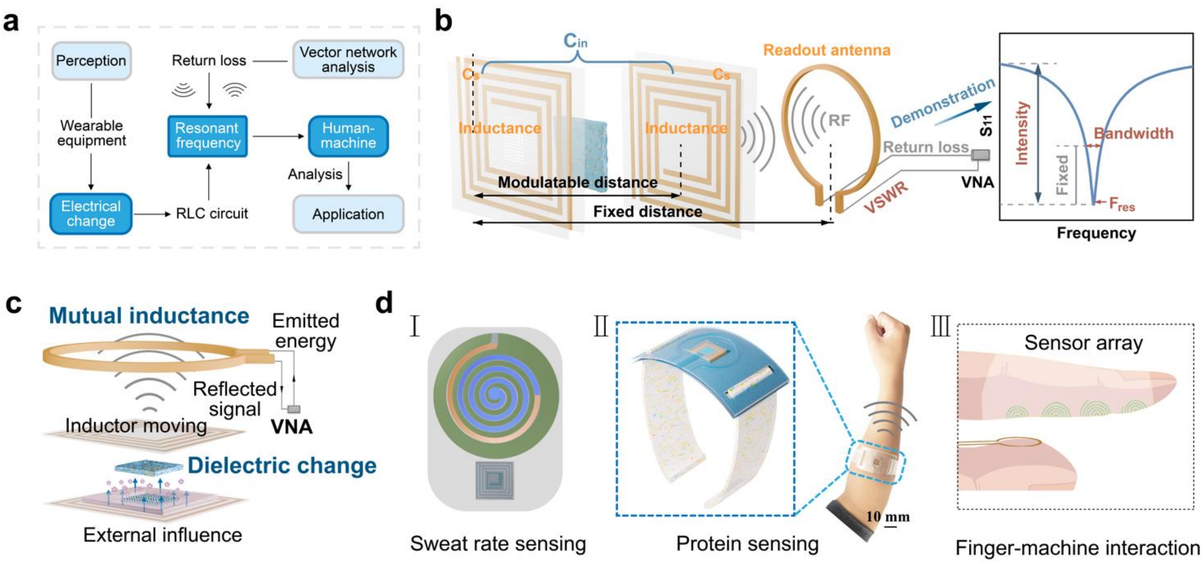

Figure. The construction and application of the sensing system. (a) The operating logic of the sensor system. （b）Analysis of equivalent electrical parameters of sensors. （c）The working principle of external wireless reading devices. （d）Application scenarios such as sweating rate monitoring, protein monitoring, and human-computer interaction.

A6

Enhanced Wireless Passive Sensing System Based on Parity-Time Symmetry and Iontronics

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Abstract: Wireless sensing systems play an important role in healthcare and environment monitoring. Although inductive-capacitance (LC) wireless passive sensing systems have been widely utilized for practical applications due to their simple structure and operation[1], they have many limitations in terms of sensitivity, resolution, sensing distance etc[2]. Recently, the parity-time (PT) symmetry theory has been proposed for the development of high performance wireless passive sensing systems[3]. PT-symmetric systems, especially near exceptional points (EPs), have exceptionally high sensitivity and resolution for wireless sensing[4]. Besides, sensor is a critical component for sensing systems. Iontronic capacitive pressure sensor is a new type of sensor that utilize electric double layer capacitance as the sensing mechanism, and is able to detect subtle pressure changes, offering great advantages for high-sensitivity detection[5].

Here, we present the integration of PT symmetry system and iontronic sensors for high-performance wireless sensing in healthcare and medicine. We introduce an innovative ionic film with gradient porous structures and high ionic conductivity, synthesized using a facile casting and freeze-drying method, to fabricate flexible iontronic pressure sensors. This iontronic sensor achieves an unprecedented sensitivity of 13786.2 kPa^{-1} and a broad pressure sensing range of 300 kPa, and is capable of distinguishing subtle pressures as low as 0.1 Pa, featuring a swift response time of 8 ms. We further integrate the iontronic sensor with PT system to develop an ultrasensitive multimodal biotelemetric system for the monitoring of intercranial pressure (ICP). The sensor system demonstrates the sensitivity of 115.95 kHz/mmHg and the sensing resolution down to 0.003 mmHg. It can also distinguish respiration and cardiac activities from ICP signals, thereby achieving the multimodal monitoring of ICP, respiratory, and heart rates within a single system, with the performance surpassing all existing technologies. Furthermore, we fabricate a biodegradable and bioresorbable iontronic pressure sensor. It has a width of less than 2 mm, and can be readily implanted into the compartment using a s puncture

needle. By integrating this sensor with the PT system, the sensor system achieves exceptional sensitivity of 7.51 kHz/mmHg and 3.01 kHz/mmHg at two eigenfrequencies respectively, and it maintain high precision in compartment pressure assessment. This combination allows for precise and continuous pressure monitoring without the need for surgical implantation or removal, providing a non-invasive and cost-effective solution for acute compartment syndrome diagnosis and long-term monitoring. The researches demonstrated great potential of the PT system and iontronic sensors for healthcare applications.

References:

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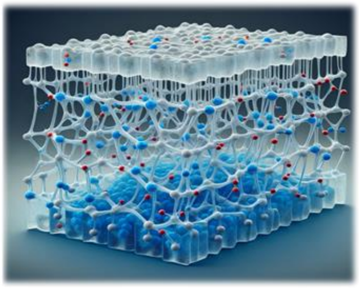
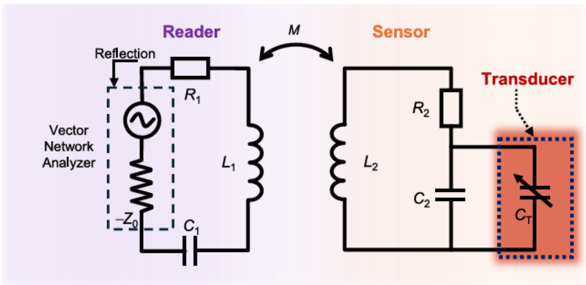
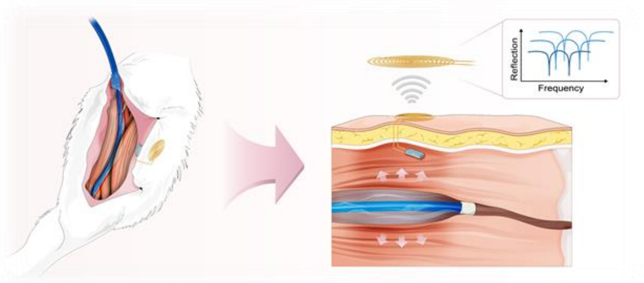


Ionic film



PT symmetry system

Multimodal ICP biotelemetric system



Injectable and biodegradable system for ACS monitoring

Fig.1 Enhanced Wireless Passive Sensing System Based on Parity-Time Symmetry and Iontronics.

B1

Multi-analyte Multimodal Sweat Analysis: Organic Electrochemical Transistor Integration for Continuous Health and Fitness Monitoring

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Sweat is a promising biofluid for non-invasive and continuous monitoring of key physiological biomarkers related to hydration, metabolism, and electrolyte balance. However, the variable nature of sweat composition and rate, along with challenges in selectivity and sensitivity, limit the effectiveness of traditional electrochemical sensors. In this work, we introduce a multimodal wearable platform that integrates Organic Electrochemical Transistors (OECTs), selective membranes, microfluidics, and wireless electronics for real-time sweat analysis. The system enables simultaneous detection of glucose, lactate, pH, sodium, and potassium concentrations, leveraging the intrinsic signal amplification, low-voltage operation, and aqueous compatibility of OECTs. Custom-developed ion-selective and enzymatic interfaces provide high specificity while mitigating cross-interference. Data are acquired and transmitted wirelessly via a custom electronic interface, supporting real-time monitoring on a mobile device. The platform was validated both in vitro and in vivo in ten human participants during controlled exercise protocols, capturing dynamic changes in sweat composition including postprandial glucose peaks. Beyond wearable applications, the OECT architecture offers a scalable foundation for future sensor miniaturisation. Its ability to transduce ionic to electronic signals directly within a compact and biocompatible footprint makes it a strong candidate

for next-generation implantable biosensing systems that require dense, low-power, and multiplexed operation within constrained environments.

Keywords: organic electrochemical transistors, wearable biosensors, sweat sensing, implantable sensors, multimodal analysis, miniaturisation, personalised health monitoring

B2

A Comprehensive Multimodal Emotion Dataset: Enhancing Valence-Arousal Representation and Personalized Emotion Recognition

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Abstract: Emotion recognition technology plays a pivotal role in mental health monitoring and human-computer interaction. Advances in multimodal emotional datasets and neuroscience methodologies have resulted in considerable enhancements in the precision of emotion recognition systems. In the future, multimodal physiological datasets are anticipated to assume an increasingly significant role in the development of personalized mental health management and emotion perception technologies. The current study emphasizes the collection of multimodal physiological signals (e.g., electroencephalogram (EEG), electrocardiogram (ECG), and pulse interval (PI)) through the integration of laboratory-controlled paradigms with wearable device applications. The aim is to establish an emotion recognition dataset that encompasses the full dimensions of valence and arousal while accommodating individual differences. The combination of video-induced emotions with the Mannheim Multicomponent Stress Test (MMST) effectively induced diverse emotional states ranging from low to high arousal and covering both positive and negative valence. Utilizing 1dCNN for classification, the accuracy rates for valence and arousal recognition derived from EEG signals attained 90.46% and 93.44%, respectively, whereas those from ECG signals reached 81.60% and 86.65%, respectively. The PI data exhibited moderate yet pragmatically valuable performance. Such findings indicate that the integration of multimodal signals can substantially enhance emotion recognition efficacy. This dataset constitutes a valuable resource for researchers in emotion recognition and computational affective science, offering significant support for personalized mental health assessment and affective computing.

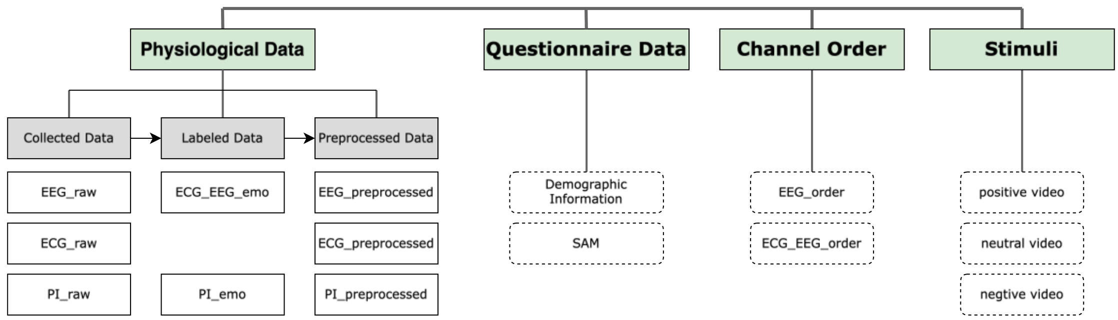

Fig.1 database structure

B3

Thermo-Responsive Biphasic Wrapping Electrode for Continuous Intraoperative Neurophysiological Injury Monitoring

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Abstract

Unintended nerve injuries during surgery can cause irreversible impairments such as motor loss or respiratory dysfunction, especially in high-risk procedures. Continuous intraoperative neuromonitoring (C-IONM) aims to prevent such damage by stimulating nerves and recording evoked EMG signals, enabling real-time assessment of nerve function. However, existing C-IONM electrodes are often limited by poor nerve conformity, complex deployment, and unstable interfaces. To address these challenges, we propose a thermo-responsive biphasic wrapping electrode (TBWE) that enables rapid self-deployment and clean removal through temperature-triggered phase change. The device integrates a thermally evaporated metal film electrode with a heat-sensitive hydrogel and a shape memory alloy (SMA) sheet, forming a programmable wrapping structure with enhanced nerve adhesion. Upon light-assisted heating, TBWE autonomously wraps around the nerve and improves signal fidelity through increased hydrogel adhesion. The interface can be detached within 30 seconds by cold rinsing, significantly reducing procedural time compared to conventional electrodes. The system is designed with a phase transition temperature of 40 °C and interfacial toughness of 100 J/m^2 to ensure safety and performance. In vivo studies on rat sciatic and pig vagus nerves demonstrate reliable stimulation, high biocompatibility, and real-time detection of traction-induced injury. A multimodal evaluation framework combining EMG and transcriptomic features further enables quantitative assessment of nerve damage. This work offers a promising solution for continuous intraoperative neuromonitoring and may support surgical decision-making in cranial, peripheral, and spinal nerve procedures.

Keywords: Continuous intraoperative neuromonitoring, Thermo-responsive electrode, Self-wrapping neural interfaces, Flexible electronics, Quantitative injury assessment.

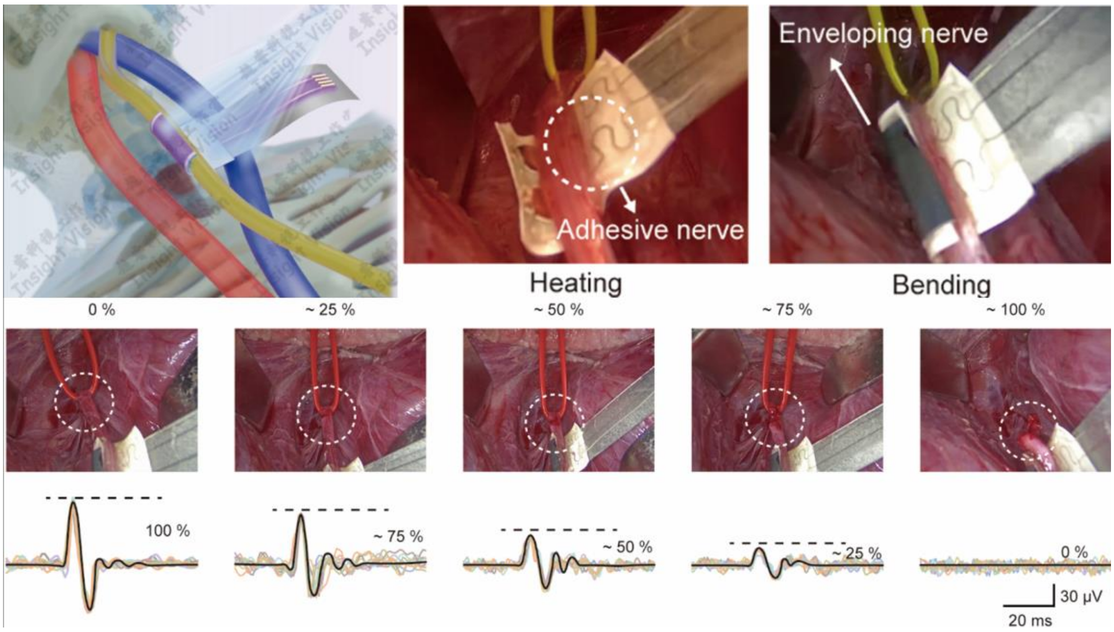

Fig.1 Thermo-responsive Biphasic Wrapping Electrodes and Application Scenarios

B4

Mechanically Adaptive and Deployable Intracortical Probes Enable Long-term Neural Electrophysiological Recordings

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Abstract: Flexible intracortical probes offer important opportunities for stable neural interfaces by reducing chronic immune responses, but their advances usually come with challenges of difficult implantation and limited recording span. In this study, we reported a mechanically adaptive and deployable intracortical probe, which features a foldable fishbone-like structural design with branching electrodes on a temperature-responsive shape memory polymer (SMP) substrate. Leveraging the temperature-triggered soft-rigid phase transition and shape memory characteristic of SMP, this probe design enables direct insertion into brain tissue with minimal footprint in a folded configuration while automatically softening to reduce mechanical mismatches with brain tissue and deploying electrodes to a broader recording span under physiological conditions. Experimental and numerical studies on the material softening and structural folding-deploying behaviors provide insights into the design, fabrication and operation of the intracortical probes. Chronically implanted neural probe in the rat cortex demonstrates that the proposed neural probe can reliably detect and track individual units for months with stable impedance and signal amplitude during long-term implantation. The work provides a new tool for stable neural activity recording and creates engineering opportunities in basic neuroscience and clinical applications.

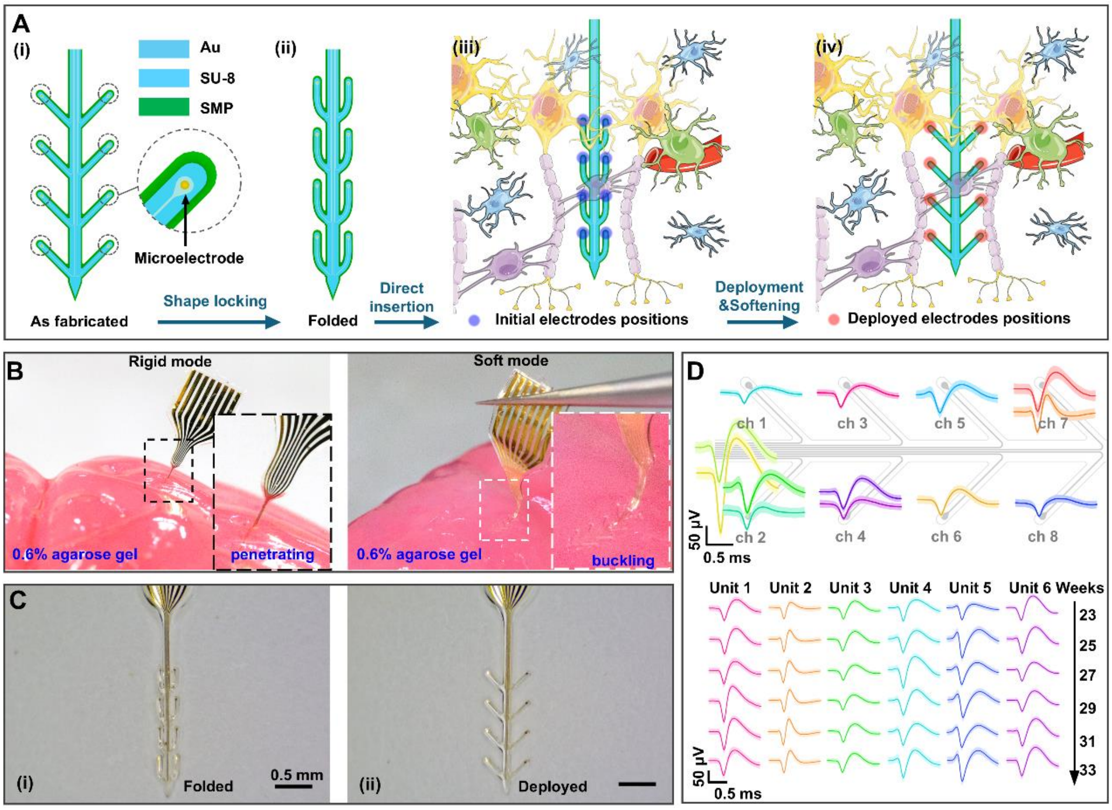

Fig.1. Design and application of the mechanically adaptive and deployable neural probe. (A) Schematic illustration of the design and principle of the mechanically adaptive and deployable intracortical probe. (B) Demonstration of the probe in the rigid/soft state. (C) Optical images displaying the probe in its folded (i) and deployed (ii) configurations. (D) Representative spike waveforms recorded in rats.

B5

Bone Fracture Healing under the Intervention of a Stretchable Ultrasound Array

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Abstract

Ultrasound treatment has been recognized as an effective and noninvasive approach to promote fracture healing. However, traditional rigid ultrasound probe is bulky, requiring cumbersome manual operations and inducing unfavorable side effects when functioning, which precludes the wide application of ultrasound in bone fracture healing. Here, we report a stretchable ultrasound array for bone fracture healing, which features high-performance 1-3 piezoelectric composites as transducers, stretchable multilayered serpentine metal films in a bridge-island pattern as electrical interconnects, soft elastomeric membranes as encapsulations and polydimethylsiloxane (PDMS) with low curing agent ratio as adhesive layer. The resulting ultrasound array offers the benefits of large stretchability for easy skin integration and effective affecting region for simple skin alignment with good electromechanical performance. Experimental investigations of the stretchable ultrasound array on delayed union model in femoral shafts of rats show that the callus growth is more active in the second week of treatment and the fracture site is completely osseous healed in the sixth week of treatment. Various bone quality indicators (e.g., bone modulus, bone mineral density, bone tissue/total tissue volume and trabecular bone thickness) could be enhanced with the intervention of stretchable ultrasound array. Histological and immunohistochemical examinations indicate that ultrasound promotes osteoblast differentiation, bone formation and remodeling by promoting the expression of osteopontin (OPN) and runt-related transcription factor 2 (RUNX2). This work provides an effective tool for bone fracture healing in a

simple and convenient manner and creates engineering opportunities for applying ultrasound in medical applications.

B6

Nanogenerators Based Self-Powered Wearable and Implantable Devices

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Abstract: Bioelectronic devices (BEDs) underpin modern biomedicine and human–machine interaction, yet conventional battery-driven systems are hampered by bulk, short lifespans and revision surgeries. Self-powered bioelectronic devices (SPBDs) harvest biomechanical energy and thus sidestep batteries, but current triboelectric and piezoelectric implants still suffer from oversized form factors, output attenuation in vivo and limited biocompatibility. To solve these issues, this research harnesses freeze-drying (FD) to engineer hierarchical porous architectures and proposes three foundational models—a homogeneous-liquid FD model that reveals how ice nucleation, growth and sublimation co-govern pore size and connectivity; a liquid/particle model that defines the kinetic threshold for particle entrapment or rejection at ice–liquid interfaces; and a liquid/nanosheet directional-gradient model that vertically aligns two-dimensional fillers through temperature-driven crystal growth. Guided by these frameworks, a motion-coupled PVDF-TrFE/PA6 FD-TENG patch delivers self-generated electrical pulses that reverse tendinopathy without implants, while an ultrafast (~0.6 s) FD bio-humidity sensor integrated with the same TENG and a wireless circuit achieves battery-free touch, motion and diaper-moisture monitoring. Directional FD further embeds vertically aligned h-BN or MoS_2 nanosheets in PVA, producing unpoled d_{33} values up to 28.8 pC N^{-1} and yielding a flexible PENG that outputs 5.9 V and 0.79 μA under 10 kPa, suitable for motion sensing and ultrasonic power transfer. Finally, a miniaturized, biodegradable piezo-triboelectric hybrid patch manufactured via the nanosheet model delivers 242 μC m^{-2} ex vivo and 84 μC m^{-2} in vivo, promoting cartilage regeneration and suppressing osteophytes in osteoarthritis models. Collectively, these FD-enabled strategies enhance energy output, flexibility, miniaturization and degradability, establishing a robust platform for next-generation self-powered wearable sensors and biodegradable implantable medical electronics.

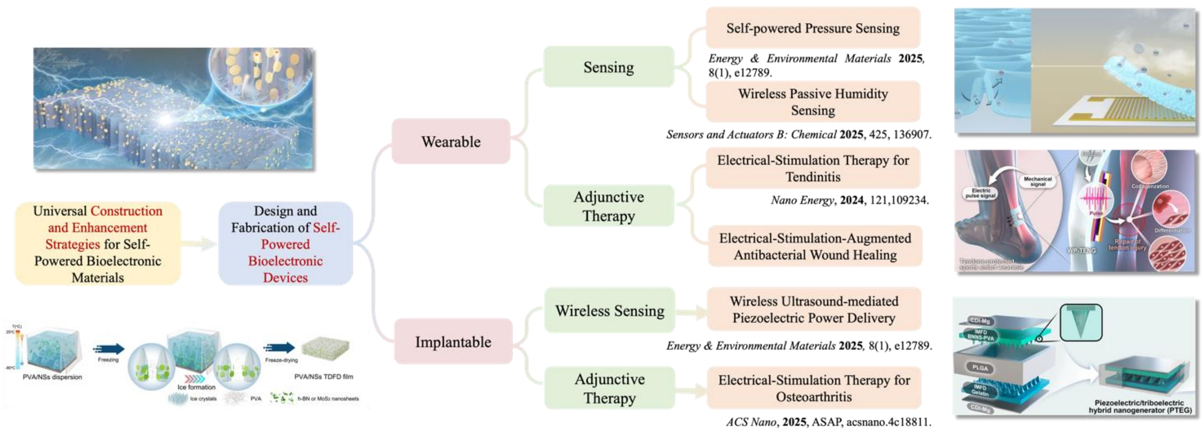

Fig.1 Nanogenerators Based Self-Powered Wearable and Implantable Devices

B7

Multiscale structured liquid metal elastomers for 3D force sensing array

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Abstract: Flexible electronic skin sensors are considered as a key enabling technology for future neuroprosthetics, human-machine interaction, and intelligent robotics. Although state of the art flexible force sensors shows high sensitivity, artificial tactile sensing to differentiate normal and tangential forces is still underdeveloped. This is particularly the case when fully mimicking human fingers for simultaneous sensing of normal stress, shear, and slip on a contact surface [1,2]. We present a liquid-metal enabled tactile sensing array with high pressure sensitivity, wide pressure sensing range, and normal-tangential force decoupling capability. The high-performance multiple tactile sensation capability is owing to its multi-scale sensing structures (Fig. 1). Aided by numerical simulation, we create an anisotropic micro-chain nanoparticle network in the composite with microporous structure. Mimicking the epidermis of human fingers, we then introduce a pyramidal surface macrostructure array. This innovation achieves a high sensitivity of 100/kPa over a wide dynamic range of 500 kPa. Crucially, this pyramidal structure can also decouple the normal and tangential forces, endowing it with 3D force direction recognition, slip detection and roughness sensing capabilities. We integrate the sensing array on a robotic gripper to achieve intelligent grasping with dynamic force adjustment for unknown objects. Our work provides a practical solution to bring the tactile sensation of humans to the sensing array, opening opportunities for unprecedented improvements in prosthetics, industrial grippers and soft robotics.

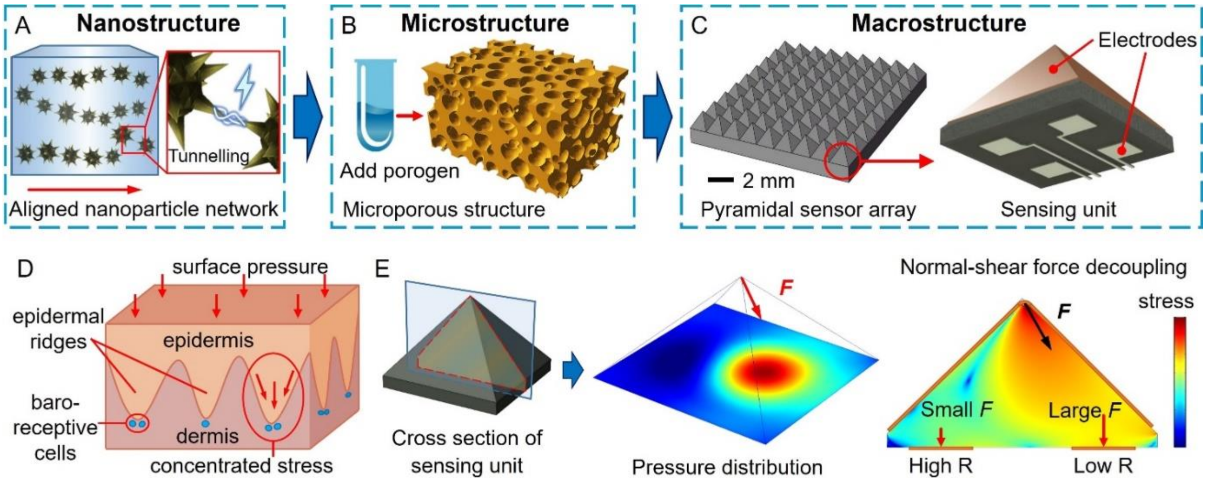

Fig.1 The multiscale structures and force decoupling principle of sensor array.

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B8

Polymer-Based Wearable Flexible Pressure Sensors for Human Health Monitoring

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Abstract: The portable pressure sensing detection system offers significant advantages in health monitoring for the elderly, chronic patients, and athletes, enabling customized health management and preventive healthcare. With the advancement of flexible materials and nanotechnology, the comfort, efficiency, and performance of the sensors have been enhanced, although challenges related to accuracy and comfort still remain. In the future, flexible pressure sensors are expected to play a greater role in personalized healthcare and precision medicine. We focus on polymer-based composite sensing materials (Polyethylene glycol/Polyaniline/Graphene), combined with direct-write and electrostatic direct-writing printing technologies, to construct flexible pressure sensors with various structures and adjustable sensitivity, along with a wireless sensing and detection system. By adjusting the number of layers and the structure of the sensing layer, the sensitivity of the sensors was fine-tuned. When the composite structure sensor had 10 matching layers, its sensitivity increased 24.4 times compared to the sensor without matching layers. For the sensor with micro-cone array structure of 27 layers, the sensitivity increased by 1.3, 9.0, and 7.0 times in different pressure detection ranges, compared to devices without the array structure. The sensors were applied in health monitoring, enabling the detection of vital signs such as pulse waves, eye movements, respiration, joint and muscle movements. Integrated with a wireless sensing and detection system, the sensors facilitate wireless signal acquisition and transmission, showing great potential for remote health monitoring.

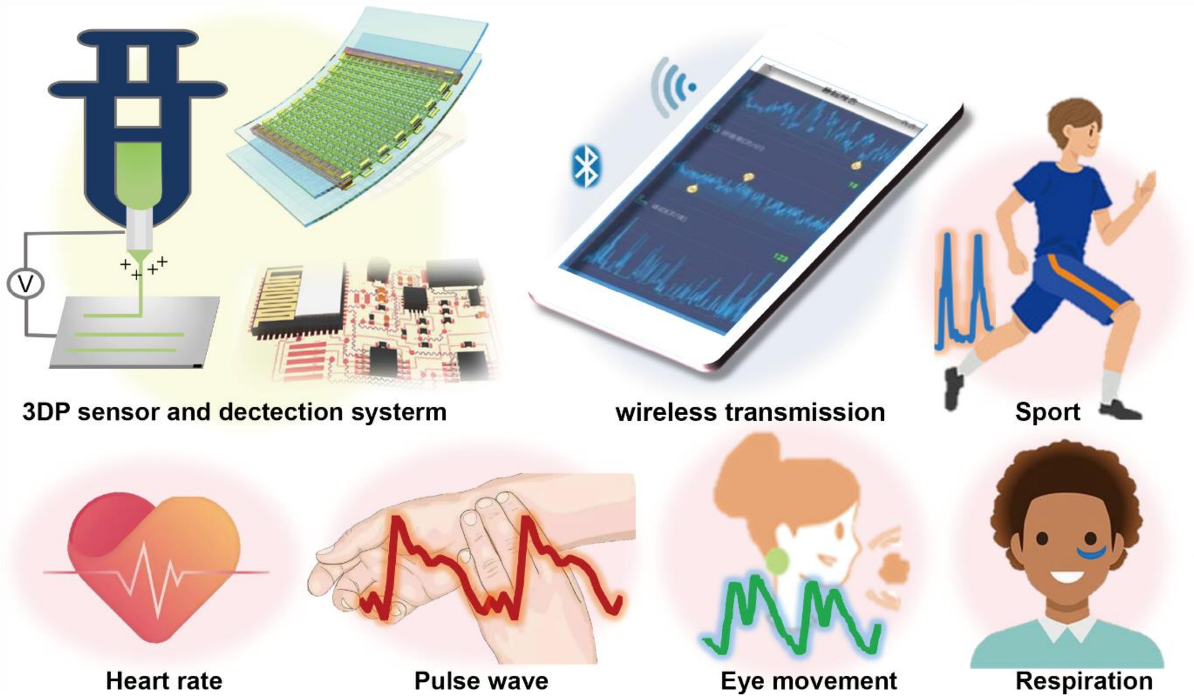

Fig.1 Wireless and Wearable Sensing Detection System and Application Scenarios

B9

Researches on biochemical sensing detection based on upconversion nanoparticles (UCNPs)

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Abstracts: Various biochemical indicators in saliva, sweat and interstitial fluid exhibit significance for medical diagnosis[1]. Notably, pH can reflect the changes in electrolyte composition of biofluid and thereby conveying information about metabolic activities[2]. The levels of purine compounds are closely related to many chronic diseases including gout and osteoporosis[3]. In this study, fluorescence sensors for detecting pH and hypoxanthine were proposed based on well-designed upconversion nanoparticles (UCNPs) with anti-Stokes properties. For the detection of pH, with the enhancement using tetra butyl ammonium hydroxide as phase transfer agent, the fluorescent probes with pH response were obtained by combining the pH response of phenol red -doped SiO_2 shell and their inner filter effects (IFE) between UCNP cores. In order to realize the sensing of hypoxanthine, hydrophilic UCNPs were combined with an enzyme-cascading system consisting of xanthine oxidase (XOD) and the Co_3O_4 NPs showing peroxidase-like activity. With the H_2O_2 produced from the XOD-catalyzed decomposition of hypoxanthine, Co_3O_4 NPs would catalyze the oxidization of substrates and produce the purple product which would effectively quench the upconversion fluorescence of UCNPs. Furthermore, the above sensing systems were embedded in agarose hydrogel to develop portable sensing hydrogels. With the assistance of smartphones and image digital analysis software, the portable sensing hydrogels could respectively realize the accurate fluorescence test of pH in the range of 6 to 8 and hypoxanthine in the range of 2.5 to 20 mg/L.

Key words: fluorescence detection; nanoenzyme; pH indicator; hydrogel; sample preparation

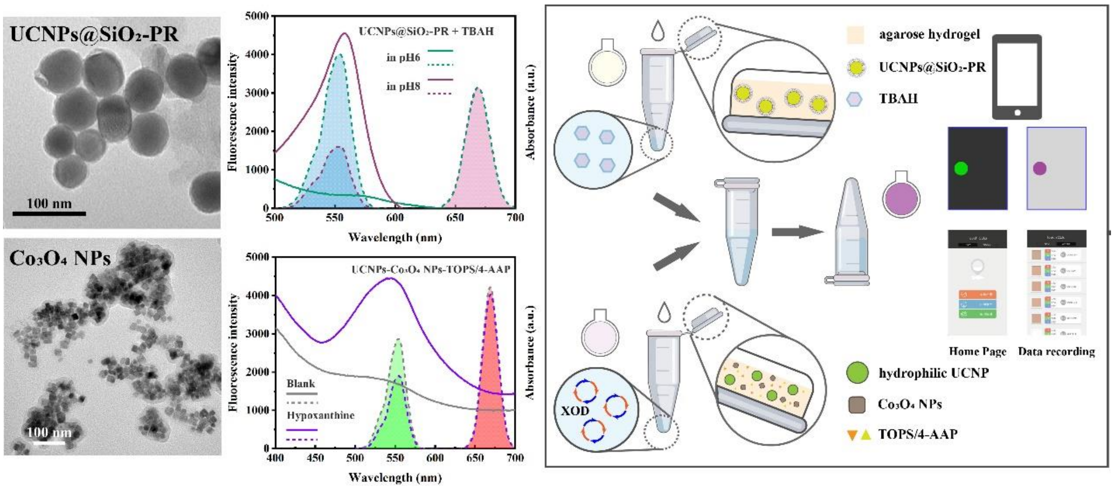

Fig.1 pH and hypoxanthine sensing detection based on upconversion fluorescent hydrogel

Reference: [1] Nature, 2024, 636(8041), 57-68. [2] TRAC-Trends in analytical chemistry, 2024, 171, 117510; [3] Nature biotechnology, 2020, 38(2), 217-224.

B10

Octopus-inspired Gradient Adsorption Patch for Stable Electrophysiological Monitoring

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Abstract

Stable and long-term electrophysiological (EP) signal monitoring is crucial for diagnoses, rehabilitation, and wearable human–machine interface (HMI) applications. However, conventional surface electrodes suffer from motion artifacts, poor skin adhesion, and insufficient long-term reliability, particularly in dynamic or humid environments. To address these issues, we present an octopus-inspired microneedle patch (OMP) that integrates a mechanically engineered microneedle–sucker–microfluidic (MSM) system for robust and tunable adhesion to the skin. The OMP features flexible sucker arrays with micropores that enable external suction control and conformal contact across complex surfaces such as hairy scalp. By coupling this with microneedles that pierce the high-impedance stratum corneum and distribute shear stress, the system minimizes motion artifacts and maintains high signal fidelity. Unlike conventional gel patches relying on van der Waals adhesion, the OMP leverages gradient suction forces generated by microfluidic channels to enhance long-term contact. Mechanical and electrical evaluations confirm its superior performance, including low artifacts and high signal-to-noise ratio in ECG, EMG, and EEG recording during vigorous movement. Finite element analysis reveals that the combined piercing and suction effects significantly improve interface stability. Sleep monitoring and SSVEP classification experiments further demonstrates the long-term monitoring reliability and hairy electrode-skin interface effectiveness. This platform shows promise in overcoming current limitations in wearable EP monitoring and enabling high-quality monitoring in clinical, athletic and HMI applications.

Keywords: Long-term dynamic interface monitoring, Octopus-inspired microneedle patch, Microneedle–sucker–microfluidic system, Gradient Adsorption, Flexible electronics.

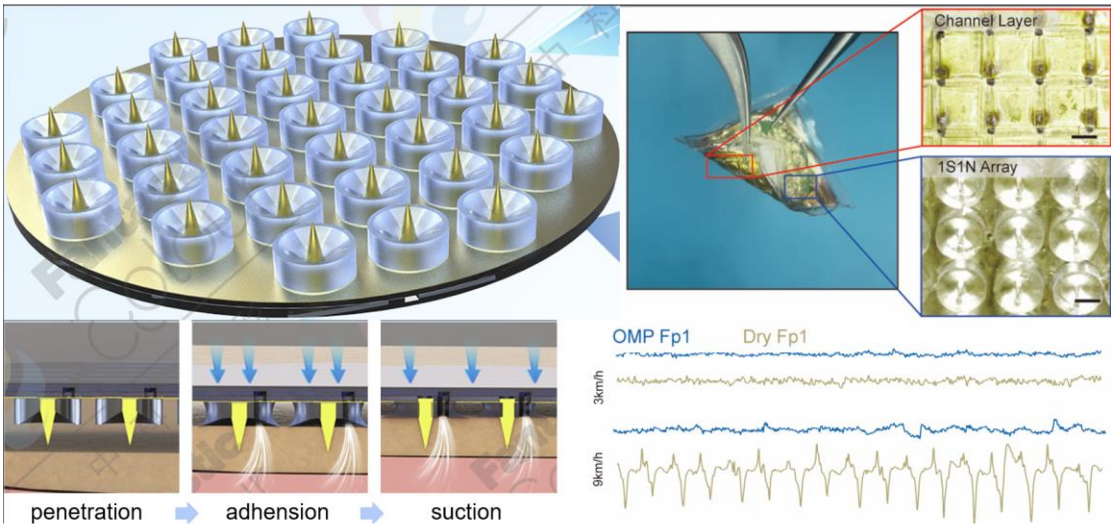

Fig.1 Overview of OMP Structure and Applications.

B11

Flexible Active-Matrix Sensing Systems Based on Metal Oxide Thin-Film Transistors

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Flexible sensors serve as the crucial bridge between artificial and biological systems, enabling seamless integration of electronic devices with living organisms. Over the past two decades, significant progress has been made in developing individual flexible sensing elements for various applications. However, the fabrication of highly integrated flexible sensor arrays capable of collecting signals over large areas remains a significant challenge, particularly when considering the requirements for high spatial resolution, uniform performance, and reliable operation.

The active-matrix addressing approach has emerged as a promising strategy for achieving high-density sensing arrays with superior performance. Within this architecture, thin-film transistors (TFTs) serve as switching elements to selectively address individual pixels for signal readout, enabling efficient multiplexing and reducing interconnect complexity. Consequently, the development of TFT arrays with low off-state leakage current, high carrier mobility, and excellent uniformity across large areas becomes paramount for constructing high-performance sensor arrays.

This presentation focuses on our recent advances in the design and fabrication of flexible active-matrix sensing systems based on metal oxide thin-film transistors. Our work encompasses two primary sensing modalities: photodetection and pressure sensing. We will discuss the manufacturing processes and device structure design strategies that enable the realization of high-density, high-performance sensor arrays. Key aspects include the optimization of metal oxide semiconductor materials, the development of novel device architectures, and the integration of sensing elements with TFT backplanes.

The fabricated flexible active-matrix sensing systems demonstrate excellent performance characteristics, including high sensitivity, low detection limits, and robust mechanical flexibility. These systems hold great promise for various emerging applications, including soft robotics, health monitoring, human-machine interfaces, and wearable electronics. We will also provide insights into the future development directions and potential applications of these flexible sensing technologies.

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B12

Label-Free Acoustoelectric Platform for Tumor Cell Isolation and Multimodal Analysis

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Abstract: Deciphering cellular heterogeneity is pivotal for elucidating pathological differences and advancing precision medicine. Conventional bulk-cell analyses obscure individual variations within populations. Single-cell analysis overcomes this limitation, providing critical insights into intercellular differences and molecular mechanisms for early diagnosis and targeted therapy of cancers and other major diseases [1]. Single-cell isolation is foundational to such analyses, ensuring reliable separation and controlled downstream processing [2]. Crucially, on-chip integration of cell isolation and analysis mitigates sample loss and minimizes cross-contamination risks inherent in transfer steps. We hereby present an integrated microfluidic platform for label-free cell sorting and multimodal single-cell analysis. Efficient separation and enrichment of rare tumor cells from large background cell populations was achieved by combining dielectrophoresis (DEP) and deterministic lateral displacement (DLD). The sorted cells are precisely captured and manipulated by acoustic surface waves (SAW) into single-cell level. Finally, integrated on-chip multimodal analysis - encompassing electrical impedance characterization, mechanical phenotyping, and high-resolution morphological profiling - facilitated highly accurate cell identification. This multimodal approach was applied to a variety of tumor cells (A549, MCF-7, HeLa, PC-3, HepG2) and achieved superior classification accuracy of over 98%. This platform demonstrates the potential of multiphysics microfluidics for seamless single-cell isolation and comprehensive analysis, offering a powerful tool for cancer research, microbiological investigations, and therapeutic development.

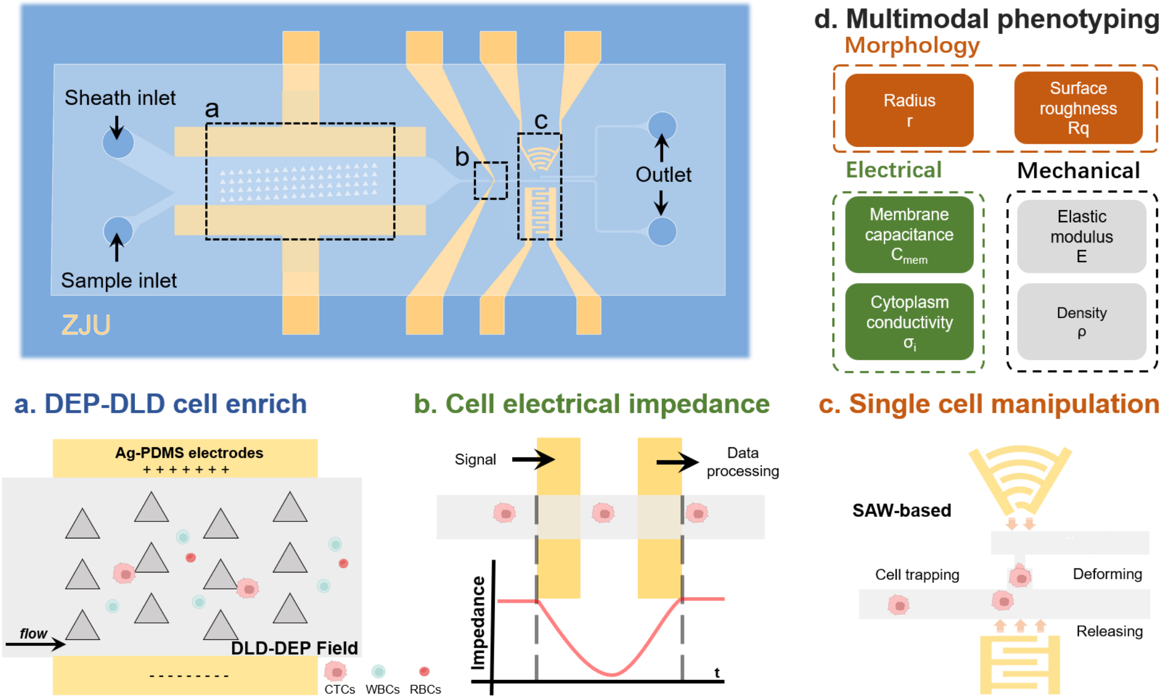

Figure 1: Working flow of the acoustoelectric platform

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C1

Generalising Murray's Law for Materials

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The performance of advanced functional materials is determined by their intricate structures. Hierarchically porous materials benefit from their multi-level and interconnected pore networks by combining the advantages of efficient mass transfer and high specific surface area. Recently, Murray's law has garnered significant research interest as a promising tool for optimising hierarchy in porous materials.[1] This biomechanics principle describes optimal biological networks for transport.[2] The bioinspired synthetic porous materials following this law, Murray materials, have been reported to excel in applications involving mass transfer processes. However, from a theoretical standpoint, Murray's law is currently not applicable to the optimisation of synthetic porous materials. The original law is based on branching tubular networks found in biological systems, whereas synthetic pores in materials often exhibit complex geometries. The discrepancy in architecture and transfer types undermines the strict usage of Murray's law to synthetic materials.

Here, I expand Murray's law for hierarchically porous materials. I derive Murray's law into a universal form and demonstrate its application in non-circular hierarchical structures. I further discuss the structural optimisation of several typical hierarchical networks and transfer types in porous materials, demonstrating this law's remarkable applicability and universality. I verify the optimal laminar flow predicted by Universal Murray's law in freeze-casted graphene oxide aerogel through experiments and simulations. Additionally, I demonstrate the practical value of this principle in gas sensors, where simply adjusting the macroscopic shape according to Murray's law improves response and recovery time. This study therefore establishes a solid theoretical foundation for future Murray material development.

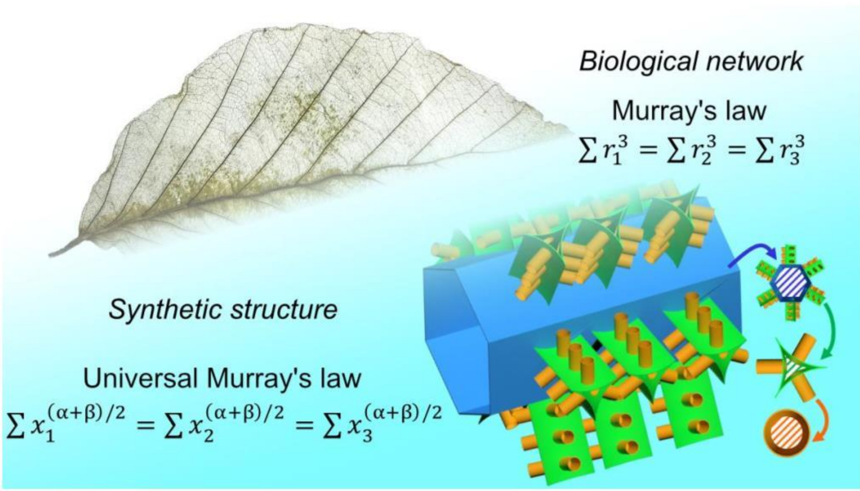

Fig.1 Generalising Murray's law for biological network to universal law for synthetic

Additionally, I would like to share unclassified research progress of silicon-based anodes in CATL during the discussion of lithium batteries.

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C2

Moiré cavity quantum electrodynamics

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Abstract— Quantum emitters are a key component in photonic quantum technologies. Enhancing single-photon emission by engineering their photonic environment is essential for improving overall efficiency in quantum information processing. However, this enhancement is often limited by the need for ultraprecise emitter placement within conventional photonic cavities. Inspired by the fascinating physics of moiré pattern, we propose a multilayer moiré photonic crystal with a robust isolated flatband. Theoretical analysis reveals that, with nearly infinite photonic density of states, the moiré cavity simultaneously has a high Purcell factor and large tolerance over the emitter's position, breaking the constraints of conventional cavities. We then experimentally demonstrate various cavity quantum electrodynamic phenomena with a quantum dot in moiré cavity. A large tuning range (up to 40-fold) of quantum dot's radiative lifetime is achieved through strong Purcell enhancement and inhibition effects. Our findings open the door for moiré flatband cavity–enhanced quantum light sources and quantum nodes for the quantum internet.

C3

Free-electron resonance transition radiation from periodic and aperiodic multilayers

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Cherenkov radiation occurs only when a charged particle moves with a velocity exceeding the phase velocity of light in that matter. This radiation mechanism creates directional light emission at a wide range of frequencies and could facilitate the development of on-chip light sources except for the hard-to-satisfy requirement for high-energy particles. Creating Cherenkov radiation from low-energy electrons that has no momentum mismatch with light in free space is still a long-standing challenge. In Ref. [1], we report a mechanism to overcome this challenge by exploiting a combined effect of interfacial Cherenkov radiation (or resonance transition radiation) and umklapp scattering, namely the constructive interference of light emission from sequential particle-interface interactions with specially designed (umklapp) momentum-shifts. We find that this combined effect is able to create the interfacial Cherenkov radiation from ultralow-energy electrons, with kinetic energies down to the electron-volt scale. Due to the umklapp scattering for the excited high-momentum Bloch modes, the resulting interfacial Cherenkov radiation is uniquely featured with spatially-separated apexes for its wave cone and group cone. Recently, we further discuss in Ref. [2] some counterintuitive features of resonance transition radiation from aperiodic multilayers.

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C4

Magnetic topological photonic crystals

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Abstract: The proposal and development of topological photonics have provided a new approach to fundamentally addressing the susceptibility of traditional photonic devices to defects or disorders, significantly enhancing the transmission efficiency and robustness of photonic devices[1, 2]. Within this overarching framework, magnetic topological photonics[3]—defined by the cooperative interplay between magneto-optical materials and precisely engineered magnetic order (ferromagnetism, antiferromagnetism, and alterferromagnetism)—constitutes a pivotal sub-field that has unveiled a host of non-trivial topological phenomena, including photonic analogues of the quantum Hall effect and chiral surface/bulk eigenmodes. Looking at the development of magnetic topological photonics, we can find that its development trajectory is generally carried out from the research of basic concepts to the research of applications. Researchers have begun to focus on the research of various application devices by taking advantage of the unique and excellent properties of these topological phenomena, and have largely developed more degrees of freedom along higher dimensions, nonlinearity, and non-Hermitian directions. This report will give a concrete introduction on two experimental achievements the group has made within the context of magnetic topological photonics: (i) the demonstration of broadband topological slow-light transport enabled by multi-Brillouin-zone winding in momentum space[4], and (ii) the realization of a photonic antiferromagnetic topological insulator exhibiting a single surface Dirac cone[5].

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C5

Laser-induced full-color printing with water-processable phase-changing material

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Abstract:

Normal printed colors rely on pigments that absorb specific light wavelengths and reflect others (e.g., red pigment reflects red). These pigments will chemically degrade and fade over time. Structural color, however, is created by microscopic structures manipulating light itself, resulting in significantly greater longevity. Nevertheless, achieving full-color images on a large scale without costly technology remains a formidable challenge compared to traditional pigment-based printing. Here, we demonstrate a novel laser-induced structural color printing method using a special phase-changing material. Under laser modulation, this material undergoes a phase transition that induces a strong change in refractive index, enabling wide-ranging and subtle control of structural color through thin-film interference. the material exhibits dramatically different water solubility depending on its phase: the unmodified material dissolves in water, while the laser-modified phase remains completely intact. This property allows for precise spatial control over both film thickness and phase distribution on a single substrate, ultimately achieving a relatively wide gamut of structural colors, which paves the way for mass-producing vibrant, fade-resistant images ideal for security features, durable displays, and archival art.

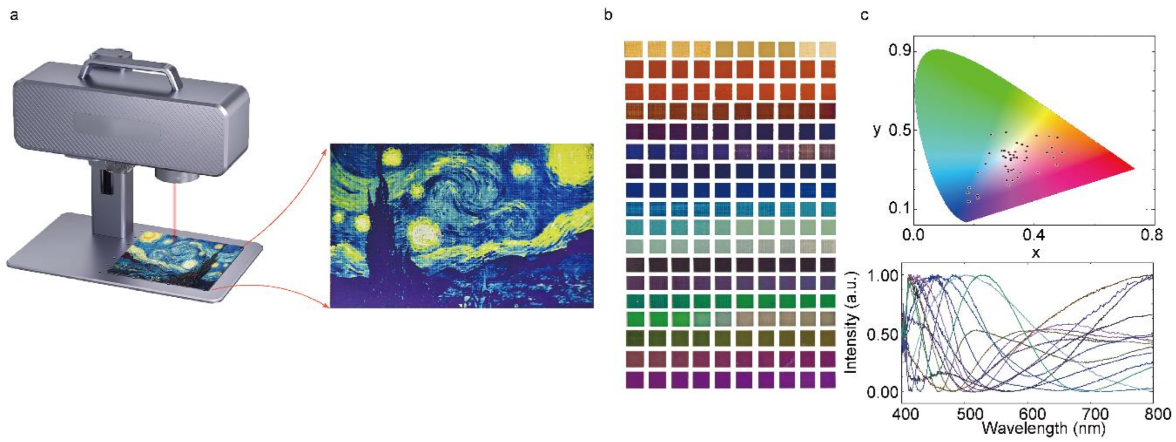

Fig.1 properties of water-processable phase-changing material thin films. a Scheme of color printing by CW laser. **b** Matrix palettes produced with various laser energies and film thicknesses. **c** CIE diagram and measured reflectance spectra Matrix palettes produced with various.

C6

Wafer-sized deposition thin films for high-mobility transistors and single-photon detectors

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This talk focuses on the wafer-scale deposition and fabrication of atomically thin films, nanomanufacturing of high-mobility field-effect transistor (FET) arrays, and the development of high-sensitivity single-photon detectors operating in the ultraviolet (VUV) range.

A novel cyclic polishing and annealing process was developed to prepare large-area, high- quality copper (111) substrates, serving as catalytic platforms for two-dimensional (2D) material growth. Utilizing a two-step carbon precursor concentration control method, wafer- scale single-crystal monolayer graphene films with excellent electrical uniformity were synthesized. Additionally, wafer-scale uniform boron nitride (BN) thin films were fabricated, enabling the construction of large-area graphene/BN heterojunction FETs exhibiting superior device performance.

Systematic studies were conducted on the modulation effects of dielectric layer thickness on the electrical characteristics of high-mobility 2D FETs, providing valuable insights for device architecture optimization and carrier transport enhancement. Vapor-phase deposition methods were developed to integrate poorly soluble small molecules into thin films, and their electrical properties were investigated through device fabrication and characterization.

A significant breakthrough includes the realization of graphene-based single-photon detectors in the EUV spectral region. Leveraging graphene’s unique optoelectronic properties, these devices demonstrate enhanced sensitivity and rapid response, paving the way for advanced UV photodetection and quantum optical applications.

In summary, this research advances the wafer-scale synthesis of 2D materials and their heterostructures, and promotes the integration of high-performance nanoelectronic and optoelectronic devices.

C7

Fractal-Inspired Inkjet-Printed Gas Sensor Arrays for Room Temperature Formaldehyde Detection

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Accurate detection of formaldehyde, a prevalent indoor pollutant and known carcinogen, remains a significant challenge for chemiresistive gas sensors, particularly at low concentrations and room temperature. This work presents an inkjet-printed, miniaturised sensor array, incorporating printed fractal electrode designs based on 1st to 4th order Hilbert space-filling curves. The fractal geometry maximizes the electric field intensity and surface area with increasing fractal order, significantly enhancing the formaldehyde detection performance. Coupled with three distinct reduced graphene oxide/metal oxide inks, our fractal-inspired 4th order Hilbert design electrode enables ultra-low power consumption (~9 microwatts per sensor) and achieves a 2.02% response to 1 part per million formaldehyde at room temperature, with a detection limit as low as 292 parts per billion. Well below the permissible exposure limits of both 750 parts per billion set by the Occupational Safety and Health Administration in the United States and 2000 parts per billion set by the Health and Safety Executive in the United Kingdom. Employing an established framework for machine-intelligent recognition, our classifier provides a decision boundary with 100% accuracy. Our scalable, low-cost fractal-inspired sensor array offers a significant advancement in room-temperature detection of formaldehyde and other volatile organic compounds, offering a significant step forward towards low power environmental sensors.

C8

Dynamic Multi-FSR Encoding for Computational Hyperspectral Imaging

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Abstract: Hyperspectral imaging acquires spatially resolved spectral signatures, enabling a wide range of applications from scientific research to industrial processes. Traditional microelectron-mechanical systems (MEMS) Fabry–Pérot (FP) spectrometers offer a compact and simple design but are limited by single free spectral range (FSR) operation. This limitation introduces a fundamental trade-off: achieving high spectral resolution necessitates narrowing the operational bandwidth. Furthermore, maintaining such high resolution demands a larger number of sampling channels, which increases the acquisition time for a single hyperspectral image and thereby limits the frame rate. Here, we present a computational hyperspectral imaging framework that achieves broadband spectral coverage and high frame rate without sacrificing spectral resolution. By dynamically modulating the MEMS-FP cavity to span multiple FSRs, we generate a set of low-correlation spectral sampling patterns as spectral encoders. When combined with a tailored reconstruction algorithm, the system accurately decodes spectral information from a significantly reduced number of sampling channels. We experimentally validate the effectiveness of our system through LED array inspection, demonstrating its potential for high-throughput defect detection in LEDs or screen manufacturing lines. Our work presents a strategy that leverages rapidly advancing computational techniques to overcome the limitations of conventional hardware architectures in hyperspectral imaging. This compact and integrable solution is particularly well-suited for deployment in resource-constrained environments.

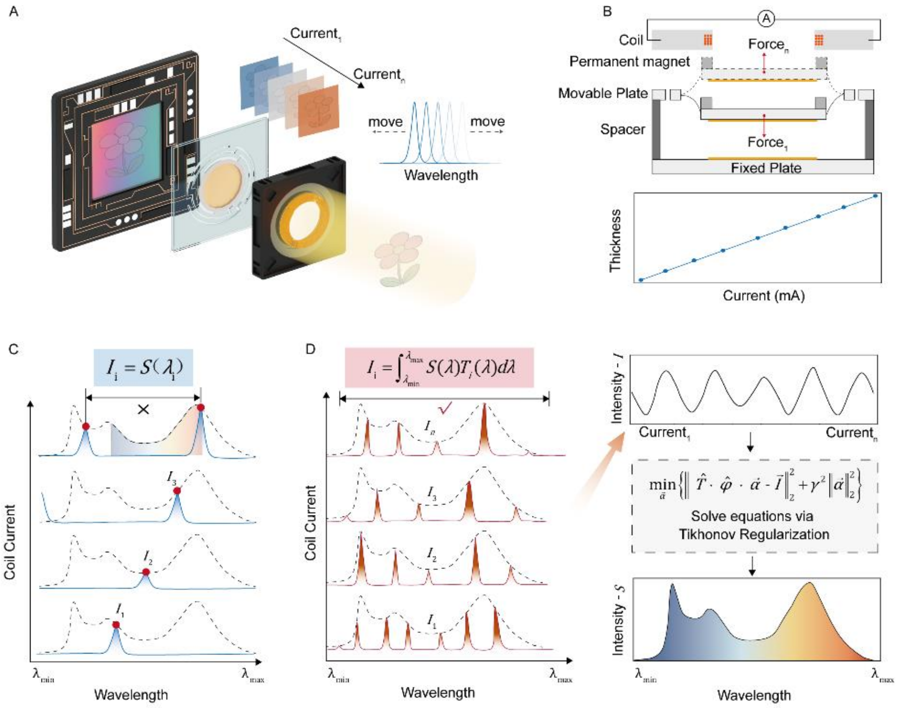

Fig. 1 | Multi-FSR encoding strategy for computational hyperspectral imaging.

C9

Frequency-Tunable Terahertz Modulators Enabled by Graphene Brickwork Metamaterials

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Abstract: Effective control of terahertz radiation requires fast and efficient modulators with a large modulation depth—a challenge that is often tackled by using metamaterials. Metamaterial-based active modulators can be created by placing graphene as a tuneable element shunting regions of high electric field confinement in metamaterials. However, conventional metasurfaces typically operate at fixed frequencies determined by their geometric design, limiting their adaptability across different spectral ranges. In combination with the finite conductivity of graphene due to its gapless nature, achieving 100% modulation depth using this approach remains challenging. Here, we embed nanoscale graphene capacitors within the gaps of the metamaterial resonators and thus switch from a resistive damping to a capacitive tuning of the resonance. By incorporating small, precisely engineered air gaps into the active elements of the metasurface structure, we can dynamically adjust the resonant frequency without introducing significant fabrication complexity. This approach is broadly applicable to a variety of LC-type resonant arrays. To validate our concept, we designed, fabricated, and experimentally tested graphene-metal metasurface modulators. As a result, we demonstrate terahertz modulators with over four orders of magnitude modulation depth (45.7 dB at 1.68 THz and 40.1 dB at 2.15 THz), and a reconfiguration speed of 30 MHz. These tuneable capacitance modulators are electrically controlled solid-state devices enabling unity modulation with graphene conductivities below 0.7 mS. The demonstrated approach can be applied to enhance modulation performance of any metamaterial-based modulator with a 2D electron gas. Our results open up new frontiers in the area of terahertz communications, real-time imaging, and wave-optical analogue computing.

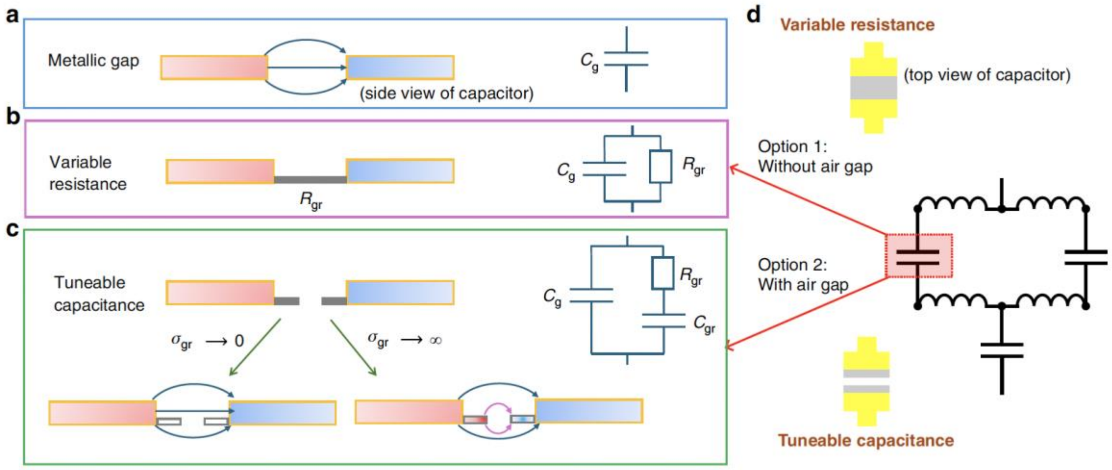

Fig.1 **Equivalent circuit of the nanoscale capacitors and the brickwork antenna arrays**. **a–c** The capacitors of the structure are presented in a side view: **a** pure metallic gap of the antenna structure, **b** continuous graphene patch shunting the antenna gap (variable resistance, no air gap) and **c** nanoscale graphene patches protruding from either side of the metallic capacitor (tuneable capacitance, air gap). **d** Equivalent circuit model of a full metamaterial unit cell. The corresponding capacitor structures are shown in a top view.

D1

High-Responsivity CVD-Grown hBN/Graphene Bolometers Operating in the C-Band

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We present a graphene bolometer fabricated on a silicon-on-insulator (SOI) platform using complementary metal oxide semiconductor (CMOS)-compatible processes and materials grown by chemical vapour deposition (CVD). The device achieves an external responsivity of 1.04 A/W in the C-band (1550 nm) at 0.4V bias with 1mW input power, without any optical enhancement structures and a change in resistance~10%. This is a tenfold improvement over previously reported CVD-graphene bolometers [1,2] and a twofold increase compared to plasmonic enhanced devices [3,4] and twisted bilayer graphene detectors [5] . The observed performance is attributed to the strong absorption (0.07 dB/μm) of graphene on our planarized SOI platform and the interaction length (80 μm), which leads to 5.6 dB loss and 72.5% absorption.

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D2

Weyl-semimetal-based Negative Quantum Capacitance Effect for the Steep-Slope logic Device

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Abstract: The emergence of Weyl physics and associated materials offers promising pathways to circumvent the fundamental limitation imposed by Boltzmann tyranny, a thermionic constraint governing the subthreshold slope that currently prevents further reduction of operating voltages and overall power dissipation, in field-effect transistors (FETs) and related devices. In this work, an ultra-thin Weyl material, WTe_2, is utilized as a floating gate to achieve steep subthreshold (SS) hysteresis-free field-effect transistors based on the negative quantum capacitance effect (NQC) induced by the Weyl nodes. This device exhibits excellent performance in electrical characteristics, with a minimum SS of 20.3 mV/dec and an ultra-small hysteresis of ~2.6 mV. In addition, the optimal area ratio between the WTe_2 and the channel (MoS_2) is found to be 1:1, and in this circumstance, a capacitance peak can be observed in the capacitance-voltage curve, suggesting the existence of the NQC effect. This effect is proposed to originate from the enhancement of the electron correlation effect as the Fermi level of WTe_2 is tuned approaching the Weyl nodes, which presents a low carrier density of state. This work benefits the design of high integration density, energy-saving devices and provides a possible method of optimizing traditional devices by introducing Weyl physics.

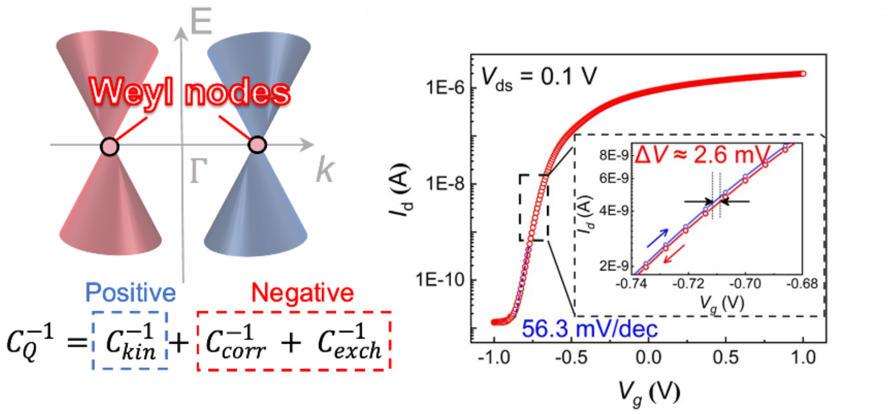

Fig.1 Negative quantum capacitance effect based on Weyl semimetals and the steep-slope switching performance

D3

Threshold-Voltage Tuning in ZnO Thin-Film Transistors: Process Development and Circuit-Level Applications

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Metal-oxide semiconductors have attracted intense interest from both academia and industry because of their low processing temperature, low fabrication cost, and high carrier mobility. Among them, zinc-oxide (ZnO) thin-film transistors (TFTs) are regarded as one of the most promising candidates owing to the earth-abundant and low cost of Zn, its environmental friendliness, high optical transparency, wide bandgap, compatibility with diverse substrates, and superior electrical performance. These attributes have enabled their widespread application in displays, flexible, transparent, and wearable electronics.

Integrated circuits based on ZnO-TFTs are still restricted to unipolar logic because high-performance p-type counterparts remain absent and alternative p-type carbon nanotubes or oxide semiconductors suffer from many drawbacks. Consequently, CMOS inverters are replaced by unipolar variants, among which the diode-loaded (E/E) inverter, which comprises two enhancement-mode TFTs, is the most widely adopted. Although easy to implement, this structure exhibits low voltage gain, poor noise margin, high static power, and limited robustness. To overcome these drawbacks, the enhancement/depletion (E/D) inverter, which offers lower power consumption, higher gain, and a smaller footprint, has been introduced. Nevertheless, the E/D structure requires dedicated processing or precise experimental conditions for threshold-voltage (V_{th}) tuning. This introduces complex processing, insufficient long-term stability, and low drive current, collectively limiting their application in high-speed circuits.

In this work, we systematically explore V_{th} modulation mechanisms in ZnO TFTs at the process level to meet the diverse requirements of switching speed and drive current in integrated circuits. A processing strategy that integrates gate-material engineering with stepwise oxygen thermal annealing is proposed to fabricate depletion-mode TFTs with tailored turn-on voltages (V_{on}). Specifically, gate electrodes with distinct work functions, such as Al, Ti, and ITO, are employed to demonstrate a wide V_{th} tuning range. Furthermore, a stepwise oxygen thermal annealing process, combined with step-by-step photolithography, enables the monolithic integration of TFTs featuring V_{on} of 0 V, -5 V, and -8 V on a single wafer, thereby overcoming conventional compatibility issues. Utilizing these methods, ring oscillators with multiple threshold TFTs exhibit different frequencies, providing a new path for the application of high frequency circuits based on ZnO TFTs.

D4

Highly Linear and Compact Thin-Film Lamb Wave Resonator with Self-Aligned Micro-Magnet for Contactless DC Current Sensing

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Abstract

This research presents a novel resonant current sensor designed for contactless, miniaturized, high-sensitivity, and high- Linearity quasi-static DC current measurement. The sensor features a cantilever structure integrated with a thin-film lithium niobate Lamb wave resonator (LWR) and a micro-magnet. The working principle of the sensor is based on the torque and force induced by the magnetic field of the measured current, which causes a resonant frequency shift of the LWR. To integrate a 30 μm thick cantilever with a 400 nm thick LWR, a dual-mask deep silicon etching process is employed. This process ensures that the structure can support the magnet while also maintaining the resonant region as a thin film that is favorable for LWR operation. Furthermore, to ensure precise magnet placement, a self-aligning process based on the attraction between the nickel layer and the magnet is introduced. Experimental results demonstrate a sensitivity of 2.2 kHz/A, a minimum current resolution of 0.6 A in open-loop testing, and a linear measurement range of up to 70 A for DC wire measurements. These results suggest that the proposed sensor has strong potential for applications in smart meters, battery management systems (BMS), and electric vehicle charging stations.

Background

Growing demand for precise current sensing in energy systems (e.g., EVs, smart grids) highlights limitations of conventional contactless sensors: Hall/TMR sensors suffer from power consumption, linearity issues, and complex fabrication [1]. Passive MEMS AC current sensors have progressed, yet DC sensing remains underdeveloped [2]—existing MEMS solutions lack continuous measurement capability, exhibit poor linearity/sensitivity, and cannot achieve miniaturization. Acoustic resonators (e.g., SAW/LWR) show potential for miniaturization and high-Q performance [3] but face inherent hysteresis when integrated with magnetostrictive materials [4], restricting linearity in DC applications. This study addresses two critical gaps: (1) DC-specific limitations of MEMS sensors; (2) Hysteresis-induced nonlinearity in resonator-based magnetic sensing. To overcome these, we introduce an LWR-based DC sensor leveraging S0-mode resonance and a self-aligned NdFeB micro-magnet structure. This design eliminates magnetostrictive hysteresis while enabling fully passive operation, directly tackling the core challenges of existing DC sensing paradigms.

Description of the New Method or System

Figure 1(a) illustrates the operational principle of the sensor: when current-carrying conductors generate a magnetic field, the magnetic force causes cantilever bending, thereby inducing deformation in the surface-mounted LWR and consequently shifting the resonator frequency. Figure 1(c) presents a cross-sectional view of the cantilever composite structure, featuring a cavity beneath the LWR to ensure Lamb wave mode excitation while retaining surrounding silicon for structural integrity to support the magnet. Figure 1(d) demonstrates the submillimeter-scale permanent magnet assembly method, where sputtered soft magnetic material on the cantilever enables spontaneous self-alignment through magnetic attraction with the permanent magnet.

Experimental Results

Figure 3 demonstrates the successful fabrication of the current sensor with a compact size of merely 1mm×2mm×1mm. Figure 2 presents the fundamental characteristics of the S0-mode LWR, exhibiting a resonant frequency of 370 MHz and a high Q-factor of 1432.15. As shown in Figure 4, the sensor achieves exceptional linearity of 99.98% within the 0-70A measurement range, with a sensitivity of 2.2 kHz/A. Figure 5 reveals the sensor's excellent repeatability under multiple current excitations of varying amplitudes, showing no observable hysteresis effects or nonlinearity typically associated with soft magnetic materials.

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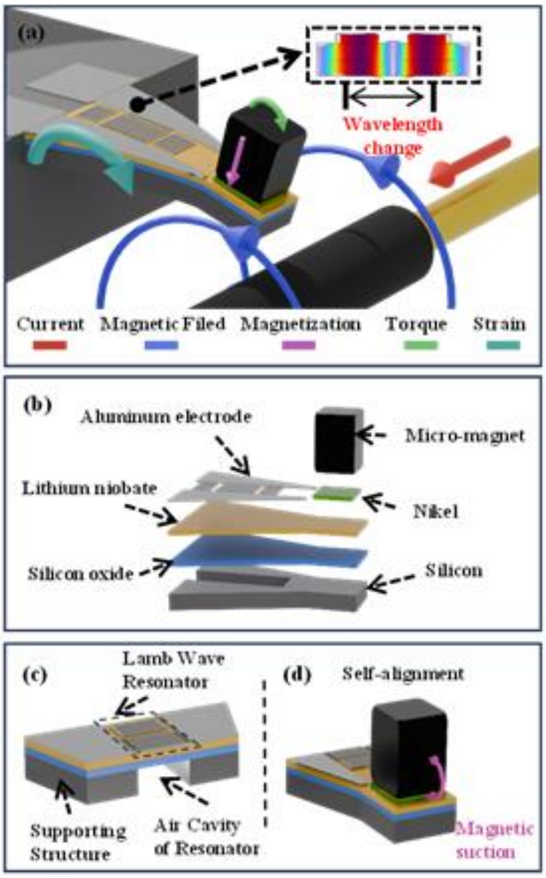

Fig. 1. (a) Schematic diagram of the sensor's working principle for current detection. (b) Exploded view of the current sensor based on LNOI. (c) Cross-sectional view of the sensor. (d) Schematic diagram of the sensor's magnet self-alignment principle.

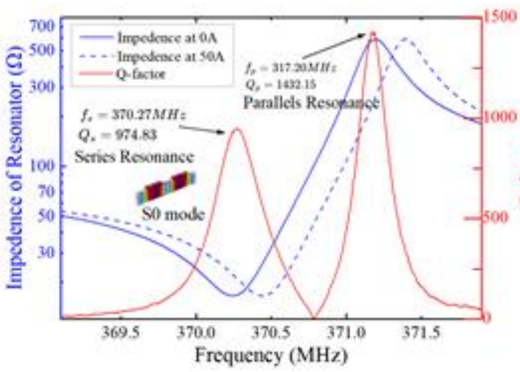

Fig. 2. Performance characterization of the S0 mode Lamb wave resonator. The blue line and blue dash line represent the electrical impedance spectrum of the resonator at 0A and 50A respectively, while the red curve illustrates the Q-factor.

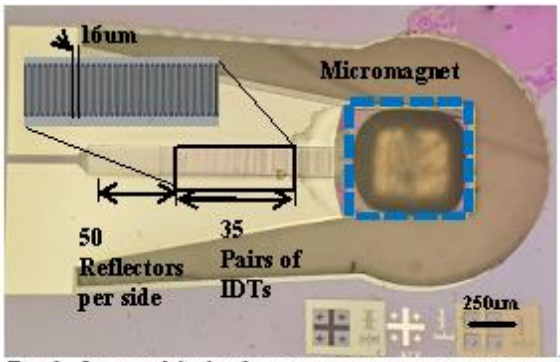

Fig. 3. Image of the lamb wave resonator current sensor with integrated micro magnet.

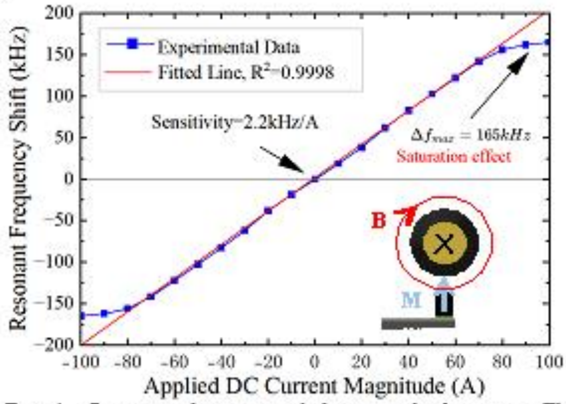

Fig. 4. Resonant frequency shift vs. applied current. The current directed into the plane is defined as positive. The blue curve represents the experimental measurement results, while the red curve indicates the linear fitting results.

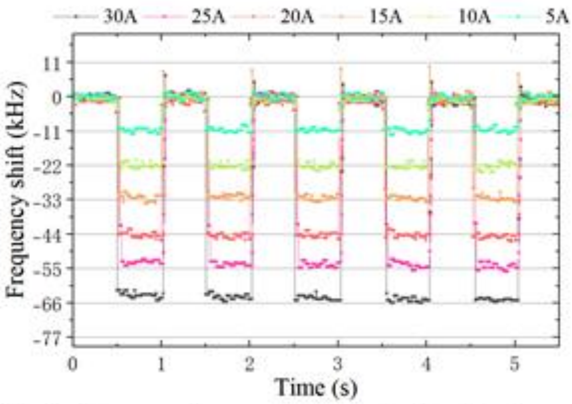

Fig. 5. The sensor's response curve in the time domain when subjected to current pulse signals with amplitudes of 30A, 25A, 20A, 15A, 10A, and 5A. The pulse width is 0.5s, and the pulse frequency is 1Hz. (x_o = 0 mm, y_o = 2 mm).

P1

Magnetized GO/NdFeB–PDMS Composites for Magnetoelastic Generators in Wearable and Ultrasound Energy Harvesting

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Abstract

Wearable and implantable bioelectronics hold great potential for continuous healthcare monitoring and therapeutic applications[1,2], yet their practical implementation is often hindered by the lack of reliable, biocompatible, and efficient power sources. Conventional piezoelectric and triboelectric nanogenerators[3,4] have been widely investigated for biomechanical energy harvesting; however, their intrinsic high impedance, low current density, and poor waterproof stability limit their operation in skin-contact and implanted environments. Magnetoelastic generators (MEGs), in contrast, utilize magneto-mechanical coupling to achieve low-impedance, high-current, and intrinsically waterproof energy conversion, making them highly promising for next-generation bioelectronics[5,6].

In this work, we present magnetized graphene oxide (GO)/NdFeB–PDMS composites as a new material platform for MEGs. By integrating NdFeB microparticles into a soft PDMS matrix with GO reinforcement, the composites exhibit strong magneto-mechanical coupling, mechanical flexibility, and biocompatibility. This strategy realizes the organic integration of magnetic materials with flexible polymers, enabling stable and efficient energy harvesting in diverse physiological conditions.

The resulting MEGs demonstrate versatile energy harvesting capabilities under two operation modes. First, under biomechanical excitation from human motion, the device generates a maximum current output of ~40 mA, sufficient for wearable healthcare monitoring systems. Second, under ultrasound excitation, the MEG achieves an output voltage of ~140 mV, current of ~2.4 mA, and peak power of ~320 μW at optimal conditions, highlighting its applicability as a minimally invasive power source for implantable devices.

Overall, this work establishes magnetized GO/NdFeB–PDMS composites as a robust and multifunctional platform for efficient biomechanical and ultrasound-driven energy harvesting, paving the way toward sustainable power solutions for wearable and implantable bioelectronics.

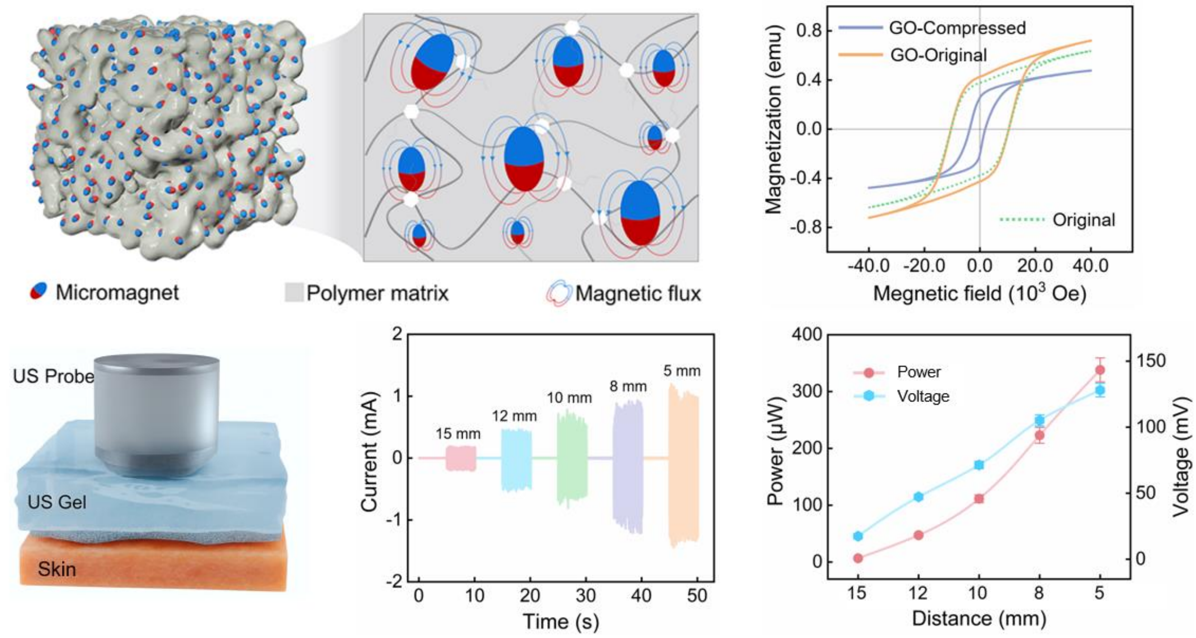

Figure. 1. Magnetized GO/NdFeB–PDMS Composites: Structure, Magnetic Properties, and Energy Harvesting Performance.

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P2

A Novel Wireless Neural Stimulator with Simultaneous Energy-Information Transmission

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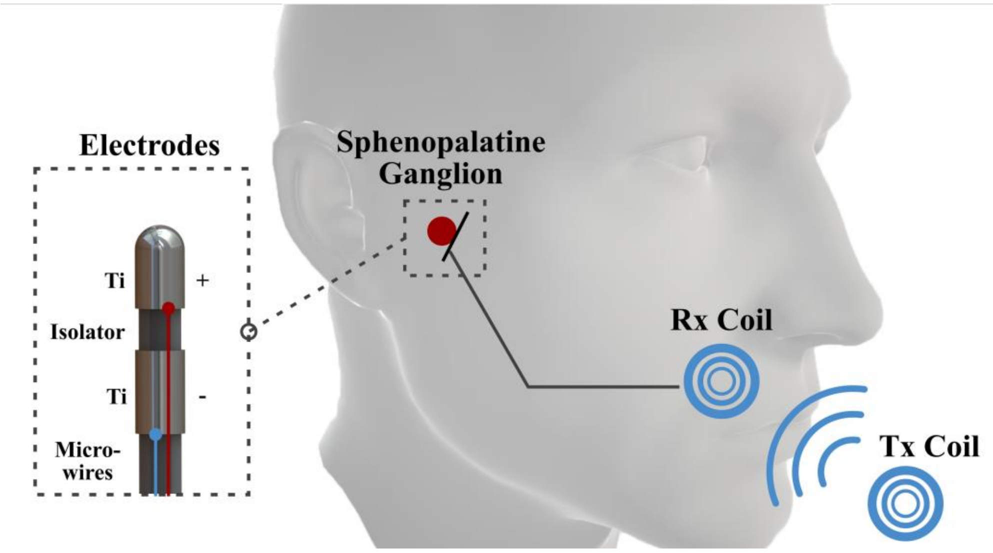
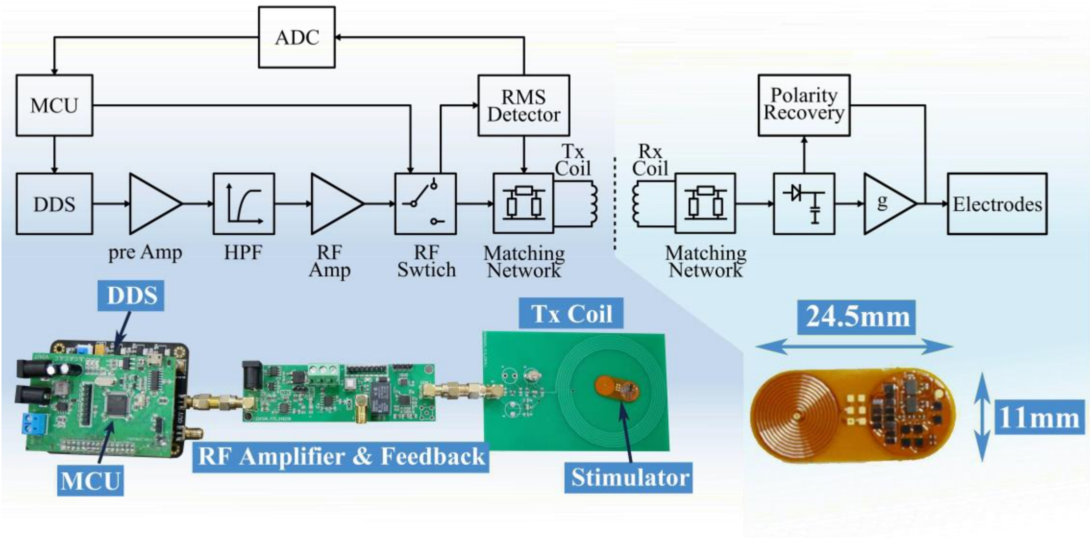
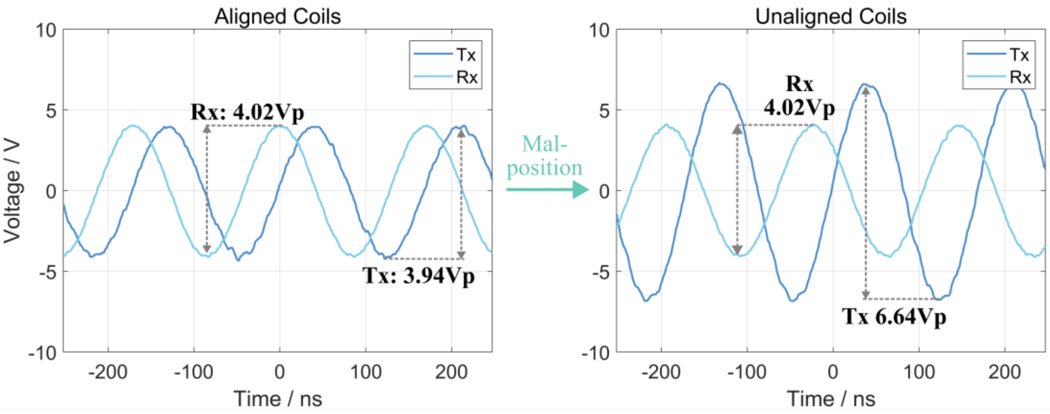
Abstract: Biomedical evidences have shown that neural stimulation is effective for the cure of certain illness. In this work we present a wireless neural stimulator with transmission of power and control signals integrated in to a single coil pair. An FPC board placed inside the oral cavity generates biphasic stimulating current, which is delivered to the sphenopalatine ganglion through miniature implant titanium electrodes. The device is capable of biphasic stimulation with output current of up to 3mA and adjustable pulse width.



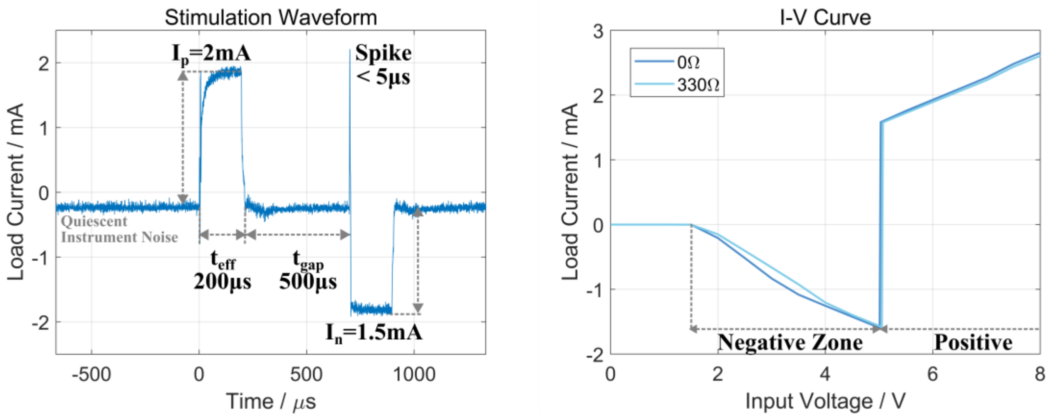
System Architecture： This device modulates the control signals onto the sinusoidal power wave in AM mode, and transmits the RF signal with a single coil set, through face tissue into oral cavity. The desired stimulation waveform is then separated on the receiver side, converted into a constant-current stimulation pulse, and its polarity is recovered.



Constant Power Transmission： The resonant frequency fr shifts when coils are not aligned. We use an RMS detector to measure the S11, and estimate the S21 factor during operation. When S11 changes, a frequency sweep is done to determine the new fr, then the Tx amplitude is adjusted to achieve constant power transmission.



Polarity Recovery: Due to the lack of constant power supply, a common non-coherent demodulator is used to separate the simulation waveform from the carrier. To recover the polarity of biphasic stimulation, we split the input voltage range into two zones, the lower indicates negative stimulation and vice versa. This is realized by changing the direction of simulation current according to the input voltage.



P3

Monolithic Multimodal Neural Probes for Sustained Stimulation and Long-term Neural Recording

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Abstract

Long-term implantable neural probes with dual-mode optical stimulation and simultaneous electrical recording are a basic tool in brain optogenetics. It combines electrical and optical functionalities to facilitate both the observation and regulation of neural loop activity in vivo. However, the integration of electrical components onto the curved and small surfaces of optical fibers is challenging. Current techniques for fabricating electrodes on the curved surface of optical fibers include inkjet printing, nanoimprinting, and water transfer printing. However, these “add-on” strategies involve sophisticated microfabrication techniques with low yield and conductive materials that cannot adhere well to the optical fiber surface. This “add-on” approach also suffers from low mechanical reliability for long-term accurate neural recording. A significantly better and robust scenario would be to fabricate electrodes inside the coating layer or the substrate of the optical fiber to create a monolithic neural probe. In this study, we present a novel method for the direct laser writing of electrode arrays onto the curved surface of optical fibers, integrating them within a biocompatible polymer coating to create monolithic neural probes. The monolithic probes demonstrate high mechanical bending endurance, stable impedance, and improved biocompatibility, resulting in a lower inflammatory response compared to conventional systems. Furthermore, our method facilitates the multilayer integration of multilayer electrodes onto optical fibers, enabling high-density electrical readout channels. The result is a versatile and scalable tool that bridges the gap between advanced optogenetic stimulation and high-fidelity electrophysiological monitoring, offering broad applicability in both basic and translational neuroscience research. This advancement represents significant progress in neuroengineering, with promising implications for future neural monitoring and modulation applications.

Keywords: Monolithic neural probes, Direct laser writing, Optogenetics, Optical fibers, Multilayer integration.

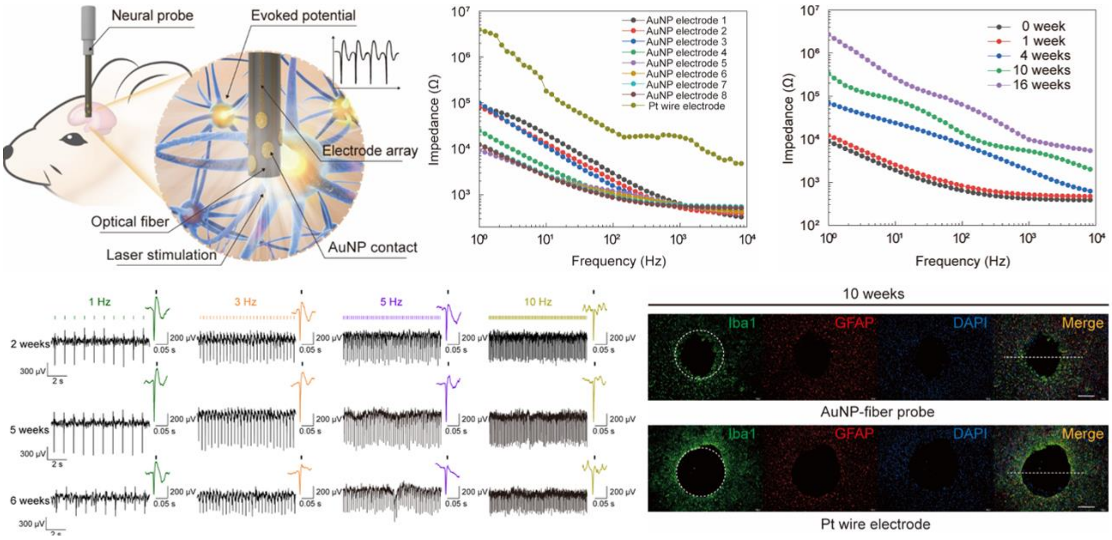

Fig.1 Monolithic Neural Probes, Performance and Application Scenarios

P4

Ion dipole interaction and directional alignment enabled high piezoelectric property polyvinylidene fluoride for flexible electronics

Dinku Hazarika[1,2,†], Jiaqi Lu[1,2,†], Jianhui Wu[1,2], Muhammad Naeem Shah[1,2], Jie Li[1,2], Kaihang Zhang[1,2], Liangquan Xu[1,2], Chuanrui Chen[1,2], Zhen Cao[1,2*], Hao Jin[1,2], Shurong Dong[1,2], Yuhui Huang[3], Qilong Zhang[3], Yongjun Wu[3], Jikui Luo[1,2*]

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Abstract: Piezoelectric materials have attracted great interest as self-powered solutions for wearable, implantable, and environmental sensing devices due to their ability to directly convert ambient mechanical energy into electrical signals[1]. Among candidate materials, polyvinylidene fluoride (PVDF) and its copolymers are widely explored owing to their flexibility, lightweight nature, and biocompatibility[2]. However, the relatively low content of the electroactive β-phase and insufficient dipole alignment remain critical limitations, leading to modest piezoelectric coefficients compared to ceramic counterparts. Here, we report a scalable approach to enhance piezoelectricity in PVDF via ionic doping and directional ion–dipole interaction (D-IDI). By introducing trace amounts of anhydrous $CaCl_2$ into PVDF and applying an external electric field during thermal annealing, Ca^{2+} ions interact strongly with CF_2 dipoles, promoting an all-trans β-phase conformation. Structural analyses (XRD, FTIR, Raman, XPS) confirm a record β-phase fraction of 92.78%, while piezoresponse force microscopy reveals a d33 of 29.26 pm/V over fivefold higher than undoped PVDF. A flexible ion-dipole interaction and directional allignment (IDI-DA) PVDF PENG device achieves >12 V output and 23 μW peak power under mechanical loading, with stable operation exceeding 60,000 cycles. Furthermore, the device demonstrates practical biomechanical energy harvesting (finger bending, walking, running) and integration into a wireless, self-powered pressure sensing system. This work establishes an effective strategy to engineer ion-dipole interactions in ferroelectric polymers, advancing the development of high-performance piezoelectric materials for wearable electronics, biomedical devices, and environmental sensing.

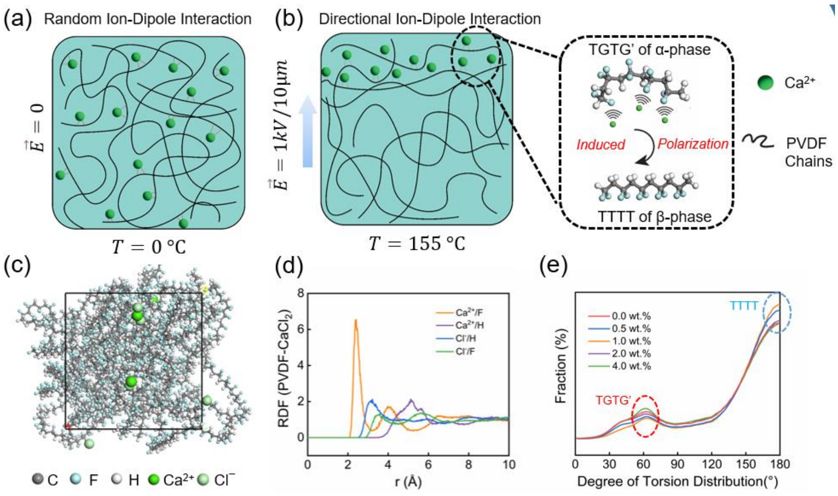

Figure. 1. Mechanism and MD simulations of PVDF doped with anhydrous $CaCl_2$.

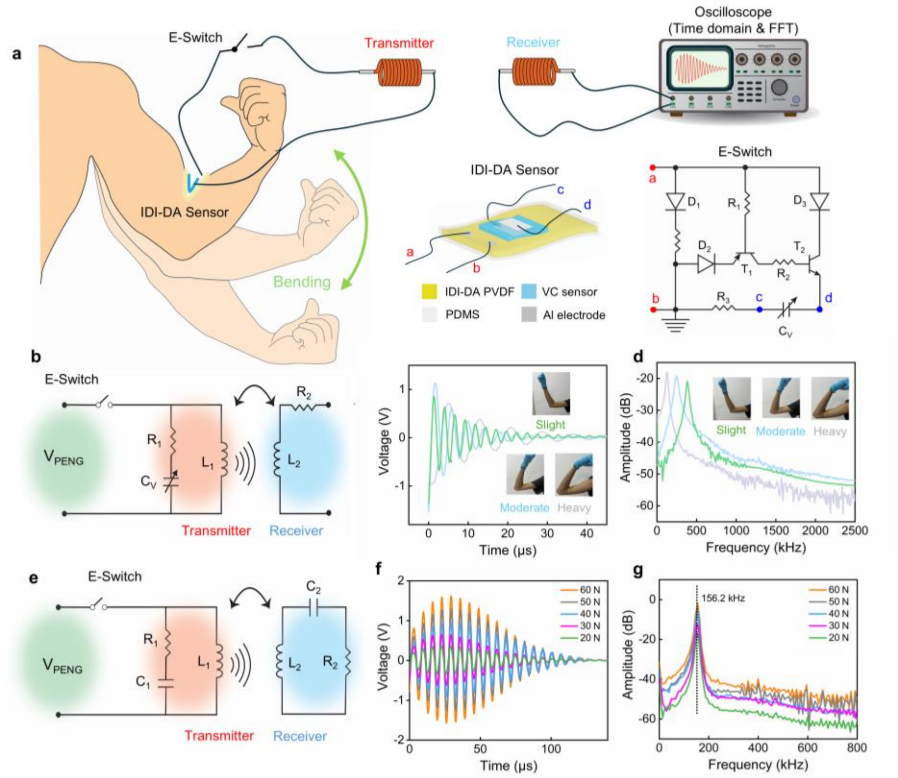

Figure.6. Self-powered instantaneous wireless sensing system based on IDI-DA PVDF transducer.

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P5

A Process Design Kit for Integrated Circuits Based on Zinc Oxide Thin-Film Transistor Technology

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Abstract: Thin-film transistors (TFTs) have been commercialized in the display industry and provide a promising alternative to traditional silicon-based electronics in applications such as display technologies, wearable devices, biosensing, and the Internet of Things (IoT). However, their applications in other integrated circuit fields are sluggish. One of the main reasons is the scarcity of process design kits (PDK) for general TFT-based circuit design, which is closely tied to the fabrication process. The process design kit (PDK) serves as a bridge connecting design and manufacturing, which leverages commercial EDA tools for efficiency and quality. To address this issue, we propose a process design kit for zinc oxide (ZnO) TFT-based integrated circuit and system design. The proposed PDK includes a primitive device library, including enhancement-mode (E-mode) and depletion-mode (D-mode) ZnO TFTs, and their device models, technology files, parameterized cells, and physical verification scripts for integrated circuit design, and is compatible with commercial electronic design automation (EDA) tools. Notably, the device model captures many unique electrical phenomena in ZnO TFTs, especially the hysteresis. And the model was verified with the measurement data, which suggested that excellent agreement is observed between the simulated and measured data. To validate the PDK, several integrated circuits were designed and fabricated. Finally, a basic standard cell library was designed and characterized using the E/D logic, and the synthesis and back-end design of an 8-bit arithmetic logic unit (ALU) was performed using the library, confirming the successful integration of the PDK with silicon-based design flows. However, we did observe situations of higher computational load using our PDK. This underscores the need for continued efforts to improve the PDK design for better performance. We hope our work can inspire other researchers to develop PDKs for their fabrication processes, thus accelerating progress in the TFT circuit design field.

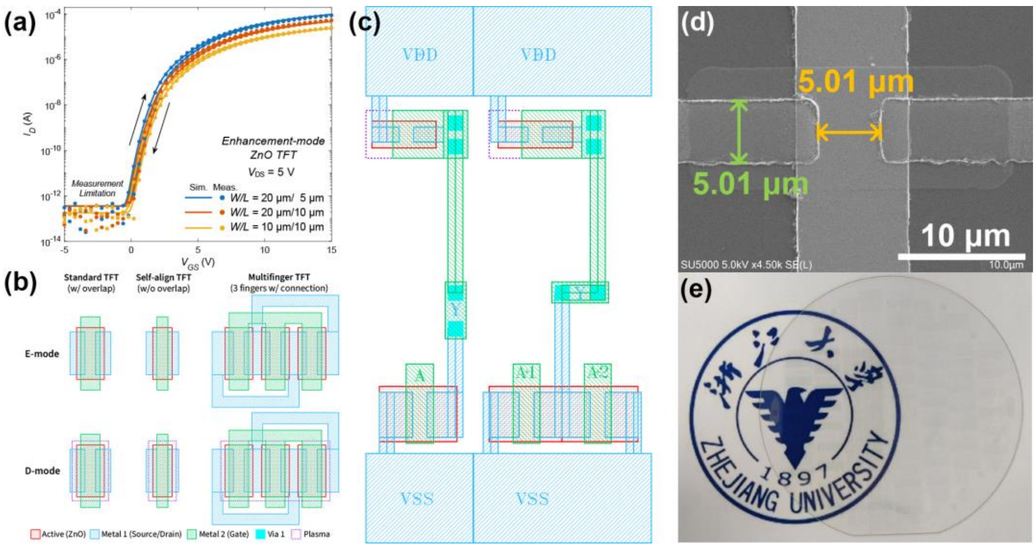

Fig. 1. (a) The transfer characteristics of the model simulation and measurement of ZnO TFTs including the hysteresis. (b) Examples of PCells of E/D-mode ZnO TFTs. (c) The layout of inverter and 2-input NOR gate. (d) The SEM image of a ZnO TFT. (e) A wafer with fabricated circuits based on ZnO TFTs showing high transparency.

P6

Regulation of Spatiotemporal Distribution of ROS by Fascia Based on Mechanoelectrochemical Coupling Mechanisms

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Abstract: Fascia is primarily composed of type I collagen, providing the extracellular matrix (ECM) for cells and serving as a key mechanical support structure in the body. It exhibits a hierarchical organization, including collagen molecules, protofibrils, fibrils, fiber bundles, and macroscopic fascial tissues, each level displaying distinct mechanical, electrical, and chemical properties. Collagen fibrils display a periodic D-banding structure with approximately 67 nm spacing, resulting from the quarter-staggered arrangement of type I collagen molecules, which may generate periodic structural patterns and localized electric field gradients due to interfacial charge asymmetry, enabling electromechanical coupling. Reactive oxygen species (ROS) are metabolic byproducts, primarily generated in mitochondria, and their distribution can be visualized using fluorescent probes. Evidence suggests that the fascial system may modulate the microenvironment and spatiotemporal distribution of ROS through mechano-electro-chemical coupling, thereby influencing redox homeostasis and tissue metabolism. Techniques such as piezoresponse force microscopy (PFM), stimulated emission depletion (STED) microscopy, molecular dynamics simulations, and fluorescence imaging enable multiscale investigation of how fascial structures, under mechanical stimulation, generate electrical signals that potentially regulate ROS dynamics. This research provides new insights into fascia as a medium for biological signal transduction, with potential implications in exercise physiology, chronic inflammation regulation, and physical therapy.

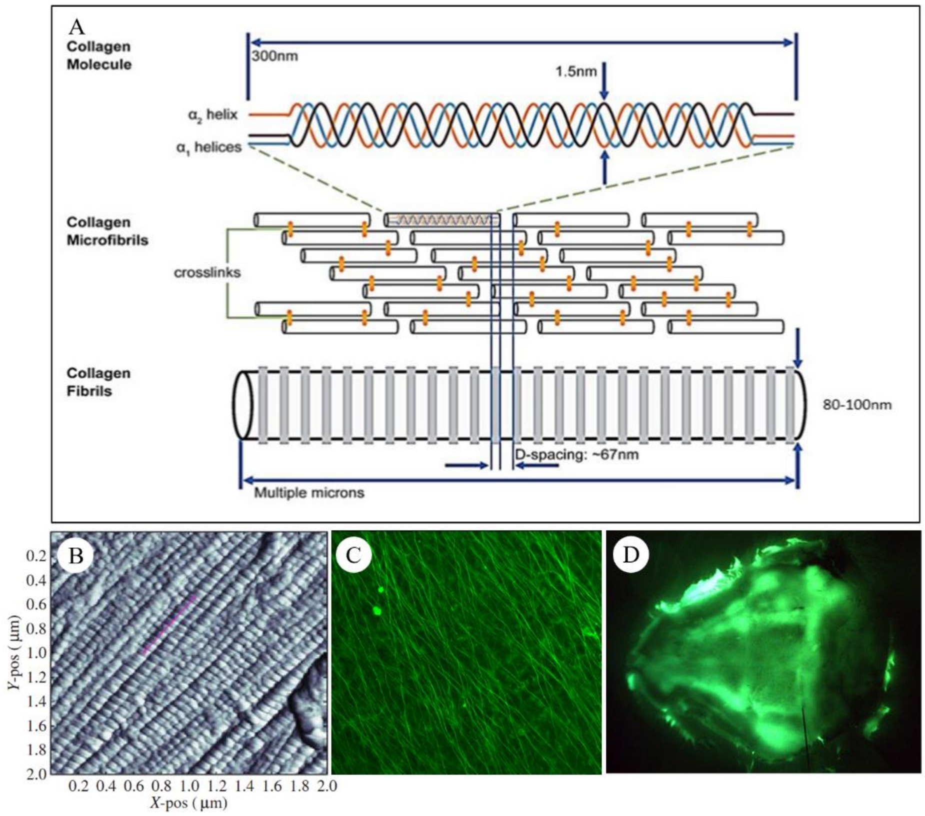

Figure 1 (A) Hierarchical structure of collagen in fascia; (B) D-periodic structure of collagen fibrils; (C) Fluorescence distribution and orientation of collagen bundles under confocal microscopy; (D) Fluorescence imaging of ROS distribution in rat scalp cranial fascia

P7

Label-free Microfluidic Impedance Flow Cytometry Coupled with Deep Neural Network for Single-Cell Cancer Classification

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Abstract: Microfluidic impedance flow cytometry (IFC) has emerged as a simple and cost-effective way to acquire a large amount of data related to cell electrophysiology parameters [1]. However, the huge computing power required for data processing and information analysis still requires a solution. Machine learning has received considerable attention due to its capability for rapid and highly accurate analysis of complex data. Neural networks have been widely used in target detection, such as face recognition, autonomous driving, text translation, and so on. The integration of neural networks with IFC provides a powerful approach for analyzing numerous electrical impedance data [2]. However, many works only focus on the morphology of cells, such as opacity, size, and elasticity. To analyze cells more accurately, it is necessary to establish an improved model based on the electrophysiology parameters. Here, we present an improved deep neural network (DNN) to analyze electrophysiology parameters for the identification of single cells using microfluidic impedance flow cytometry. We use a four-frequency measurement system based on lock-in amplifiers to collect the electrical impedance data. Three types of cancer cells passed through the microfluidic channel and the electrical properties could be recorded and simultaneously extracted using our models. The identification of cells was verified with an accuracy of 93% using machine learning.

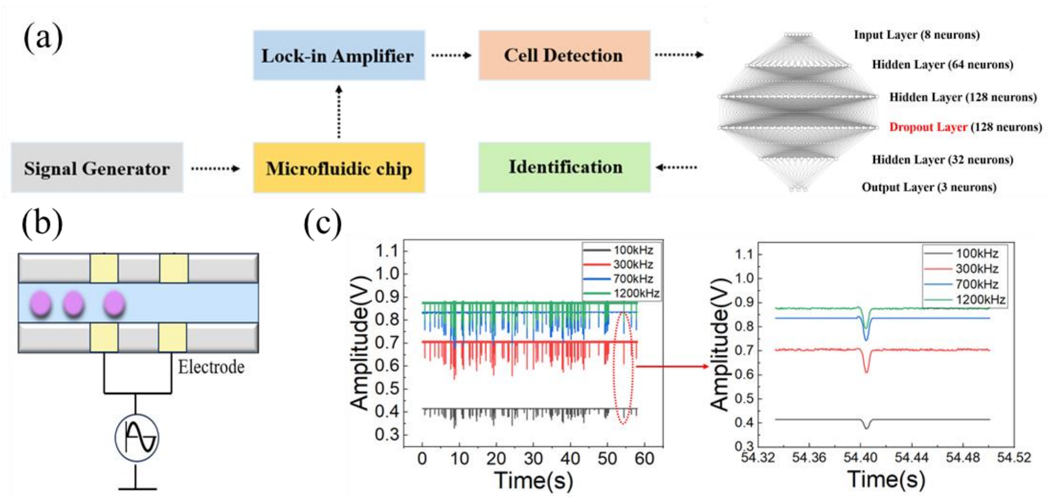

Figure 1: (a) Workflow diagram of the cancer cells identification system. (b) Coplanar electrode electrical detection structure of the microfluidic chip. (c) Impedance data of four frequencies extracted from electrodes. The image on the right represents a locally magnified rendition of the image on the left.

Reference:

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P8

Rapid and Sensitive Cancer Biomarker Detection Using Flow-through Immunoassays with Integrated Au Nanorod Arrays

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Abstract: Fluorescence immunoassays are the gold standard for biomarker detection and play a crucial role in clinical diagnosis [1]. However, traditional fluorescence immunoassays are normally carried out in 96-well plates, which remain constrained by several drawbacks such as limited sensitivity, complicated operation process, and bulky equipment. Advances in lab-on-a-chip (LOC) technology have spurred the development of diverse microfluidic devices proposed for streamlined flow-through immunoassays. In this work, we report the integration of Au nanorod arrays with microfluidic chips to achieve rapid and sensitive flow-through immunoassays. The nanorods are fabricated through a one-step physical deposition method called oblique angle deposition (OAD) without relying on advanced lithography tools. Taking advantage of this platform, we demonstrate the detection of cancer biomarkers, including prostate-specific antigen (PSA) and carcinoembryonic antigen (CEA), with significantly improved sensitivity and shortened assay time. The detection limit of PSA and CEA can reach down to 2.9 pg/mL (~0.1 pM) and 131.4 pg/mL(~1.8 pM), respectively, which corresponds to an enhancement of 1000 and 400 times compared with conventional glass devices. Owing to its high assay performance and a simple manufacturing process, this platform has great potential in applications of point-of-care (POC) diagnosis.

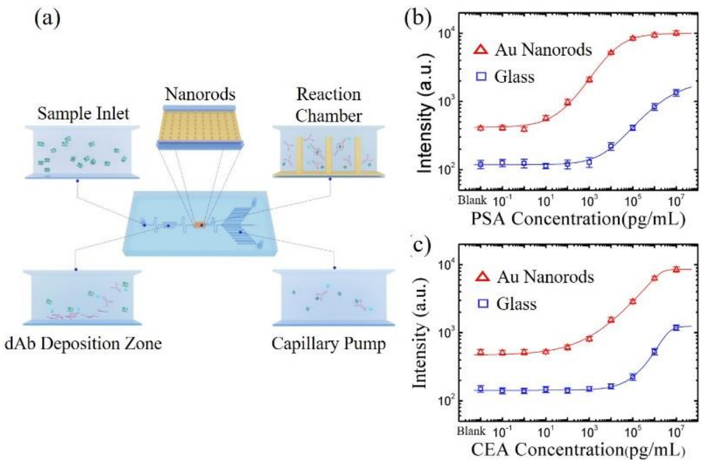

Figure 1: (a) Conceptual illustration of the flow-through microfluidic chip integrated with Au nanorod arrays for one-step immunoassay of biomarkers. (b, c) The calibration curves of PSA and CEA detection using flow-through immunoassay chips with integrated nanorod arrays and bare glass substrates.

Reference:

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P9

Reversible Exciton Modulation in Monolayer MoS_2 via Acoustic Control of Oxygen Physisorption

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[2] International Campus, Zhejiang University, Haining 314400, China

Abstract

Two-dimensional transition metal dichalcogenides (TMDCs), such as monolayer MoS_2, exhibit strong light–matter interactions and prominent excitonic effects, making them promising candidates for tunable optoelectronic and photonic devices. However, achieving dynamic and reversible modulation of excitonic properties under ambient conditions remains a significant challenge. In this work, we demonstrate a novel approach using film bulk acoustic resonators (FBARs) to generate localized acoustic fields that dynamically modulate excitonic states in monolayer MoS_2. The acoustic field alters the physisorption of ambient O_2 molecules on the MoS_2 surface, inducing reversible p-type doping that markedly enhances photoluminescence (PL) intensity, with a maximum enhancement factor of 4.4 observed at 90 mW. The modulation process is reversible, non-destructive, and the device fabrication is fully compatible with CMOS fabrication techniques. Our findings reveal how phonons affect surface–exciton interactions, a form of indirect exciton–phonon coupling, and offer a practical platform for real-time optical modulation in 2D semiconductors, with potential applications in phonon-engineered photonic devices, reconfigurable neuromorphic systems, and exciton-based sensing technologies.

P10

Laser-induced full-color printing with water-processable phase-changing material

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Abstract:

Normal printed colors rely on pigments that absorb specific light wavelengths and reflect others (e.g., red pigment reflects red). These pigments will chemically degrade and fade over time. Structural color, however, is created by microscopic structures manipulating light itself, resulting in significantly greater longevity. Nevertheless, achieving full-color images on a large scale without costly technology remains a formidable challenge compared to traditional pigment-based printing. Here, we demonstrate a novel laser-induced structural color printing method using a special phase-changing material. Under laser modulation, this material undergoes a phase transition that induces a strong change in refractive index, enabling wide-ranging and subtle control of structural color through thin-film interference. the material exhibits dramatically different water solubility depending on its phase: the unmodified material dissolves in water, while the laser-modified phase remains completely intact. This property allows for precise spatial control over both film thickness and phase distribution on a single substrate, ultimately achieving a relatively wide gamut of structural colors, which paves the way for mass-producing vibrant, fade-resistant images ideal for security features, durable displays, and archival art.

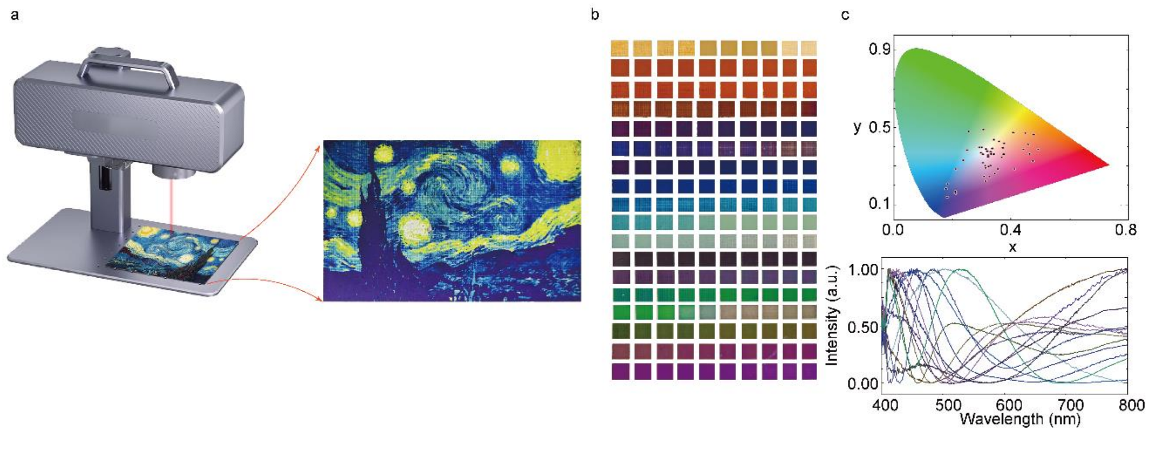

Fig.1 properties of water-processable phase-changing material thin films. a Scheme of color printing by CW laser. **b** Matrix palettes produced with various laser energies and film thicknesses. **c** CIE diagram and measured reflectance spectra Matrix palettes produced with various.