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應用物理及材料工程研究院
INSTITUTO DE FÍSICA APLICADA E ENGENHARIA DE MATERIAIS
INSTITUTE OF APPLIED PHYSICS AND MATERIALS ENGINEERING

IAPME Newsletter

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✧ Content

❖ Publications (IF≥8, and/or nature Index; *corresponding author)

1. **Zekun Yan**, **Hongwei Cheng**, **Yupeng Liu**, Wenfeng Xu, Quansheng Cheng, Lingyun Li, Xue Wu, Yingqi Liang, Jing Zhao, Gang Liu*, Shaoping Li*, **Songnan Qu***. Reprogramming Tumor Cell Death via Processing Natural Drug to Carbon Dots Overcomes Collagen Barrier and Activates Antitumor Immunity. *Advanced Functional Materials*, 2522706 (2025). DOI: 10.1002/adfm.202522706. **[2024 IF=19.0]**

RESEARCH ARTICLE

ADVANCED FUNCTIONAL MATERIALS
www.afm-journal.de

Reprogramming Tumor Cell Death via Processing Natural Drug to Carbon Dots Overcomes Collagen Barrier and Activates Antitumor Immunity

Zekun Yan, Hongwei Cheng, Yupeng Liu, Wenfeng Xu, Quansheng Cheng, Lingyun Li, Xue Wu, Yingqi Liang, Jing Zhao, Gang Liu, Shaoping Li,* and Songnan Qu**

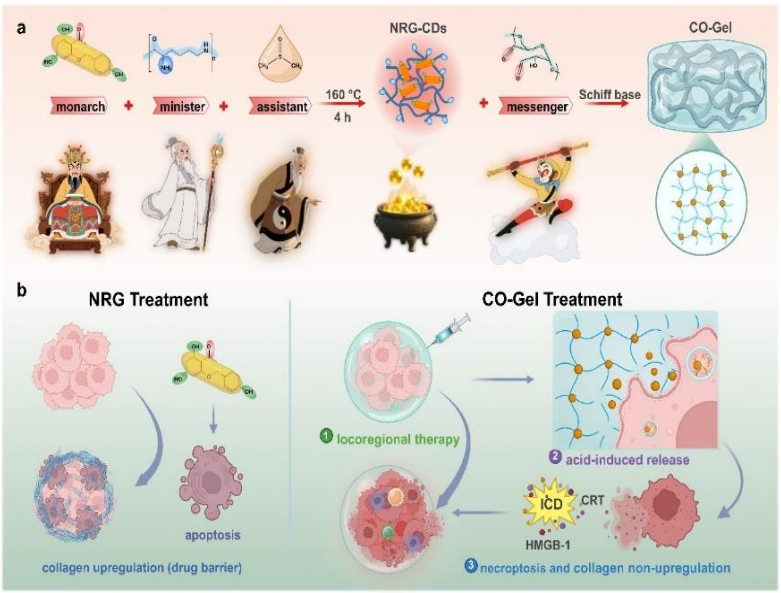
❖ Research Stories

UM research team developed Reprogramming Tumor Cell Death via Processing Natural Drug to Carbon Dots Overcomes Collagen Barrier and Activates Antitumor Immunity

- This work develop a Traditional Chinese Medicine (TCM)–inspired carbon dot nanoplatform that converted natural drug naringenin into carbon dots (NRG-CDs) to reprogram cancer cell death from apoptosis to necroptosis, thereby collapsing drug-induced collagen barriers and activating immunogenic cell death. NRG-CDs were further integrated into a pH-responsive injectable hydrogel (CO-Gel) via Schiff-base linkage with oxidized dextran.
- The injectable pH-responsive CO-Gel enables local, sustained release that suppresses primary tumors and inhibits metastasis through robust antitumor immunity.

from left:

Ms. Zekun Yan (閻澤堃), Dr. Hongwei Cheng (程紅偉), Dr. Yupeng Liu (劉鈺鵬), Prof. Songnan Qu (曲松楠)



Zekun Yan, **Hongwei Cheng**, **Yupeng Liu**, Wenfeng Xu, Quansheng Cheng, Lingyun Li, Xue Wu, Yingqi Liang, Jing Zhao, Gang Liu*, Shaoping Li*, **Songnan Qu***. Reprogramming Tumor Cell Death via Processing Natural Drug to Carbon Dots Overcomes Collagen Barrier and Activates Antitumor Immunity. *Advanced Functional Materials*, 2522706 (2025). DOI: 10.1002/adfm.202522706. **[2024 IF=19.0]**

This work was supported by the Science and Technology Development Fund of Macau SAR (0139/2022/A3, 0005/2024/AKP, 0002/2024/TFP, 0007/2021/AKP), University of Macau – Dr. Stanley Ho Medical Development Foundation "Set Sail for New Horizons, Create the Future" Grant 2025 (SHMDF-OIRFS/2025/001).

❖ Ph.D. Student Thesis Oral Defenses

Mengwei Wang of Prof. Shuangpeng Wang & Prof. Kar Wei Ng's group presented "Efficient and Stable NiOx-based QLEDs via Advanced Hole Injection Engineering" in her oral defense on November 19, 2025.

Congratulations to Dr. Mengwei Wang!

(from left) Prof. Hongchao Liu (劉宏超) , Prof. Songnan Qu (曲松楠), Prof. Kar Wei Ng (吳嘉偉), Dr. Mengwei Wang (王夢薇), Prof. Shuangpeng Wang (王雙鵬), Prof. Wenyu Ji (紀文宇, JLU) and Prof. Shi Chen (陳石)

❖ Delegation of Quzhou Smart New City Chamber of Commerce Visited IAPME

On November 24, 2025, our Institute welcomed a delegation from the Quzhou Smart New City Chamber of Commerce (衢州市智慧新城商會), led by Mr. Yongping Zheng (鄭勇平), President of Zhejiang Shangyi Energy Saving Technology Co., Ltd. (浙江上易節能科技股份有限公司董事長).

During the visit, Prof. Songnan Qu provided an overview of our Institute's development trajectory and its core research priorities. Together with Prof. Guoxing Sun, the professors highlighted the institute's recent advancements in several cutting-edge fields, including: optoelectronic and energy storage devices, carbon dot-based biomaterials and foam concrete materials.

The enterprise representatives expressed strong interest in fostering collaboration with our researchers. Both parties discussed opportunities to jointly accelerate the transformation of research outcomes into practical applications, particularly in areas such as foam concrete materials.

❖ Upcoming Events

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IAPME Seminar

Meta-Optics Empowered Terahertz Devices

4 December 2025

Prof. Quan XU
Tianjin University
Venue: N23-4018
Time: 10:00 - 11:00
Hosted by: Prof. Hongchao LIU

Abstract

Terahertz waves, situated between infrared and microwave regions in the electromagnetic spectrum, exhibit significant application value in security screening, radar systems, and particularly next-generation wireless communications (6G). Consequently, research on terahertz science and technology has flourished since the early 21st century. During the same period, meta-optics—an approach leveraging subwavelength artificial microstructures to tailor electromagnetic responses—has undergone rapid development. The convergence of these fields provides an unprecedented platform for designing terahertz functional devices. This presentation will introduce terahertz functional devices based on meta-optics, focusing on two key aspects: 1) Free-space terahertz wave manipulation devices, including waveplates, lenses, gratings, and holographic plates; 2) On-chip devices bridging free-space terahertz waves to on-chip integrated optoelectronic systems. These devices, characterized by compact structures and on-demand multifunctional integration, hold significant potential to propel 6G communications development from the bottom up.

Biography

Prof. XU is currently an Associate Professor at the School of Precision Instruments and Optoelectronics Engineering, Tianjin University. He obtained his Ph.D. degree from Tianjin University in 2019, during which he conducted research visits to King Abdullah University of Science and Technology in Saudi Arabia and the University of Birmingham in the UK. His research focuses on terahertz photonics and terahertz meta-devices. Currently, he serves as a Youth Editorial Board Member for Research and Infrared and Laser Engineering.

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IAPME Seminar

Mimicking the Multifunctionality of Ion Channels by Electrostatically Gated Graphene Nanofluidics

4 December 2025

Prof. Yahui XUE
Southern University of Science and Technology

Venue: N23-1004b
Time: 10:30 - 11:30
Hosted by: Prof. Pengzhan SUN

Abstract

Biological ion channels acting as life's transistors can gate simultaneously fast and selective ion transport through atomic-scale filters to maintain vital life functions. However, the quest of artificial structures to mimic biological systems for medical, sensing and energy applications has been hindered in achieving simultaneous ion selectivity, fast transport, and electrical gating at atomic scale. Recent progress in atomic-scale ion transistor research from fundamental mechanisms to potential applications will be firstly introduced. The atomic-scale ion transistor made of graphene channels of 3 angstrom size achieves simultaneously ultrafast and highly selective ion transport controlled by electrical gating. The underlying mechanism is attributed to the highly dense packing of ions and their concerted movement inside the graphene channels. we also report a subnanometer trilayer graphene (TLG) nanopore with a conical structure as a switchable biomimetic ion filter under electrostatic gating. The nanopores show high ion selectivity and rectified current–voltage characteristics. Inspired by the ultra-sensitive thermoelectric response of thermoTRP channels, boosted thermoelectric response in voltage-gated graphene nanofluidic channels will also be discussed. I will show that a voltage-gated nanofluidic synapse can also be developed based on atomic-scale graphene channels, which exhibits both short- and long-term plasticity. The cation-π interactions at graphene surface enable the nanofluidic synapse to exhibit ultra-long-term memory.

Biography

Prof. Yahui XUE is currently an Associate Professor at the Department of Mechanics and Aerospace Engineering in Southern University of Science and Technology (SUSTech). He received his B.S. in 2009 and Ph.D. in 2015 from College of Engineering at Peking University. Before joining SUSTech in 2021, he worked as a postdoctoral researcher in the Department of Mechanical Engineering at University of California, Berkeley. He received the Lloyd Hamilton Donnell Applied Mechanics Reviews Paper Award from ASME and has authored peer-reviewed articles in prestigious journals including Science, Nature Communications, PRL, Advanced Materials and JFM. His research interests lie in extremely confined ion transport under multifield coupling, microfluidic flow and heat transfer, micro- and nano-mechanics.

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IAPME Seminar

Synergistic Nanofluidics between Soft and Hard Condensed Matter

4 December 2025
Prof. Alessandro SIRIA
Shenzhen University
Venue: N23-1004b
Time: 11:30 - 12:30
Hosted by: Prof. Pengzhan SUN

Abstract

Carbon nanomaterials exhibit peculiar properties in terms of water permeation, ultra- low hydrodynamic friction and exalted ionic transport. These results challenged the classical description of water-carbon friction and they lead to a novel theoretical rationalization of fluid transport in nanochannels based on coupling between collective excitations of electrons in the solid and molecules in the liquid. Although this new framework seems to reconcile the existing results for water transport at interfaces of graphene and carbon nanotubes, the demonstration of quantum liquid-solid friction is still missing. In this talk we revisit the current state of art of fluid transport at nanoscale and we will present recent experimental investigations of the complex coupling between fluid behavior and the electronic properties of confining materials.

Biography

Prof. Alessandro SIRIA, Distinguished Professor at Shenzhen University and Honorary Professor at Tsinghua University, is a renowned expert in nanofluidics, soft matter, and interfacial science—pivotal fields advancing energy and separation technologies. His research explores key mechanisms, including ionic/fluid transport in nanoconduits (e.g. carbon/boron-nitride nanotubes), radius-dependent flow slippage, ultra-high nanoscale friction, and giant osmotic energy conversion. Previously serving as CNRS Research Director and PSL-CNRS Chair Professor at Ecole Normale Supérieure (ENS) Paris, he has published over 50 international refereed papers (20+ in Nature/Science groups), holds 10+ patents, and secured prestigious ERC Starting and Proof of Concept grants. A serial entrepreneur, he co-founded 5 tech startups with a total funding of over $92M. Recipient of CNRS Excellence Prizes and overseas high-level talent honors, he has supervised 12 graduate students and 10 postdocs, while holding key roles in European and national research networks.

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IAPME Seminar

Emulating Brain Functions via Iontronics? Theoretical Insights

4 December 2025

Prof. Zhiping XU
Tsinghua University

Venue: N23-1004b
Time: 14:30 – 15:30
Hosted by: Prof. Pengzhan SUN

Abstract

Brain information processing emerges from the coupled dynamics of ion transport and chemical modulation. Neurons encode, amplify, and store electrochemical signals through ion channels governed by charge-selective migration, diffusion, and reaction kinetics. Understanding these electrochemical coordination principles is key to developing bio-inspired systems, such as memristor networks and neuromorphic architectures, that emulate brain-like computation. Iontronics links physical variables, including ion mobility and interfacial barriers, to cognitive functions like memory and decision-making, offering a platform to probe the physics of intelligence and design biologically grounded learning. We present a theoretical framework for iontronic systems that integrates multiscale dynamics, chemical specificity, and biological variability, outlining challenges toward stable, scalable, and adaptive architectures uniting physical and biological intelligence.

Biography

Prof. Zhiping XU earned his B.S. and Ph.D. from Tsinghua University. After postdoctoral research at Rice University and MIT, he returned to Tsinghua, where he is now a Professor of engineering mechanics and director of the Institute of Solid Mechanics. His research interest spans the mechanics and physics of synthetic materials and living systems, with a focus on understanding the complexity and evolutionary nature of matter. His work integrates computational modeling, experimental techniques, and machine intelligence. Prof. Xu actively collaborates with the aerospace, nuclear engineering, and semiconductor industries.

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IAPME Seminar

Intercalation in 2D materials and in-situ studies

4 December 2025

Prof. Zhiyuan ZENG
City University of Hong Kong
Venue: N23-4016
Time: 15:00 - 16:00
Hosted by: Prof. Guichuan XING

Abstract

Intercalation of atoms, ions, and molecules is an effective means of tuning the properties of two-dimensional materials, while in situ imaging and spectroscopy provide powerful tools for deciphering intercalation dynamics and mechanisms. Firstly, we developed a lithium ion battery intercalation & exfoliation method with detailed experimental procedures for the mass production of 11 2D transition metal dichalcogenides (TMDs) and inorganic nanosheets, such as MoS_2, WS_2, TiS_2, TaS_2, ZrS_2, graphene, h-BN, $NbSe_2$, WSe_2, Sb_2Se_3 and Bi_2Te_3, among them 3 TMDs achi eved mono- or double layer yield > 90%. The Li insertion can be monitored and finely controlled in the battery testing system, so that the galvanostatic discharge process is stopped at a proper Li content to avoid decomposition of the intercalated compounds. Secondly, we discovered that small current and high cut-off voltage (0.005 A g^{-1}, 0.9 V) produces pure 2H WS_2 bilayers. while large current and low cut-off voltage (0.02 A g^{-1}, 0.7 V) leads to 1T' WS_2 monolayers. For lithium intercalation mechanism, the state-of-the-art In-Situ Liquid Phase TEM is an ideal technique for identifying the phase changes during intercalation process. Combining with in-situ XAS, XRD and Raman, etc, the underlying lithium intercalation mechanism in TMDs were elucidated to achieve scalable production. For water decontamination, our metallic 1T/1T′ phase 2D TMDs (MoS_2, WS_2, TaS_2, TiS_2) nanosheets exhibited exceptional Pb^{2+} removal capacity (up to 758 mg·g^{-1}) with treatment capacity of 55 L-water/g-adsorbent for feeding Pb^{2+} concentration of 1 mg·L^{-1}, which is 1-3 orders of magnitude higher than other 2D materials and commercial activated carbon, holding great potential as Point-of-use (POU) devices. Then, a one-step covalent functionalization of MoS_2 nanosheets was used for membrane fabrication, which exhibits rejection rates of >90% and >80% for various dyes and NaCl in reverse osmosis (RO). After that, we found that 1T′-MoS_2 electrode demonstrates exceptional volumetric desalination capacity of 65.1 mgNaCl cm^{-3} in capacitive deionization.

Biography

Prof. Zhiyuan ZENG received his BSc, Mphil and PhD degrees all in MSE from Central South University, Zhejiang University and Nanyang Technological University in 2006, 2008 and 2013, respectively. After 4 years postdoc at Lawrence Berkeley National Laboratory (LBNL) and 2 years Engineer working in Applied Materials Inc. (Silicon Valley), he joined the Department of Materials Science and Engineering, City University of Hong Kong in 2019, and was promoted as Associate Professor in 2024. His research interests are using lithium intercalation strategy, in-situ liquid phase TEM technique to investigate Transition-metal dichalcogenides (TMDs), which can be used for energy and environmental applications.

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IAPME Seminar

Thin-film transistor-based active-matrix digital microfluidics

5 December 2025

Prof. Hanbin MA
University of Electronic Science and Technology of China
Venue: N23-4018
Time: 10:40 - 11:20
Hosted by: Prof. Songnan QU

Abstract

Electrowetting-on-dielectric as a liquid sample handling platform has been widely used in digital microfluidic systems for miniaturizing bio-laboratory processes. Droplet manipulations are enabled by programmable electrodes control. Active-matrix technology overcomes the scalability limits of passive electrode arrays by embedding transistors to each pixel, enabling high-throughput control over droplets across large-area arrays. In this talk, I will introduce the importance and development of digital microfluidics. I will present results on thin-film transistor-based active-matrix digital microfluidics platforms, and its broad applications on life sciences research. Future prospects of active-matrix digital microfluidics will be discussed.

Biography

Prof. Hanbin MA, Professor at University of Electronic Science and Technology of China. He is the founder of ACX instruments, which was spun out from the University of Cambridge and the Chinese Academy of Sciences in the Cambridge Science Park, UK in 2016.

Prof. Ma received his PhD degree in Engineering from University of Cambridge, UK. From 2014 to 2018, he was supported by Isaac Newton Trust and other projects at the University of Cambridge as a Research Fellow. From 2018 to 2025, he worked at the Chinese Academy of Sciences as a Hundred Talent Professor in CAS Key Laboratory of Bio-Medical Diagnostics, Suzhou Institute of Biomedical Engineering and Technology. He then moved to University of Electronic Science and Technology and Sichuan Provincial People's Hospital. He has authored or co-authored more than 80 peer-reviewed articles. He holds more than 50 awarded and pending patents. His current research is focused on large-area electronics-based biosensing systems and active-matrix biochips.

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IAPME Seminar

Polyelectrolyte-Confined Nanofluidics

4 December 2025

Prof. Ping YU
Chinese Academy of Sciences

Venue: N23-1004b
Time: 15:30 - 16:30
Hosted by: Prof. Pengzhan SUN

Abstract

The behaviors of ion transport in confined channels are strongly related to the geometry and chemistry of channels. Polyelectrolytes are one kind of typical substrate with rich chemistry. By grown polyelectrolytes brushes onto the inner wall of micro/nanopipette by ATRP (atomically transfer radical polymerization), the polyelectrolyte brushes-confined nanofluidic configuration were successively and controllably obtained. With this configuration, several counterintuitive ion transport behaviors were observed, such as microscale ion current rectification, ion current rectification reversion for monovalent anions and ion current oscillation. Based on these fundamental behaviors, various sensors with high spatiotemporal resolution, especially for in vivo analysis, were developed. More recently, the hysteresis phenomenon was observed in polyelectrolyte brushes-confined nanofluidic. Typical three fingerprint characteristics of memristor were observed at polyelectrolyte-confined nanofluidic system. Moreover, the typical neuromorphic functions, such as PPF, PPD and dynamic filter properties were also realized. More importantly, chemical-related neuromorphic functions (i.e., chemical-electrical signal transduction) were for the first time accomplished, showing promising application in brain-mimic computing and brain-computer interfacing. We have also realized the neuron functions with polyelectrolyte brushed-confined nanofluidic with both electrical and chemical responsibility. We think the polyelectrolyte brushes-confined nanofluidic paved a way of tuning ion transport behaviors with rich chemistry and tunability, which would feature more diversity and tunability for the nanofluidic-related applications.

Biography

Prof. Ping YU is currently a Professor in Key Laboratory of Analytical Chemistry for Living Biosystems at ICCAS. She was a recipient of the "LU JIAXI Award for Junior Scientists" from CAS and the "National Outstanding Young Scholars" of China. Until now, she has published more than 150 papers, which was cited more than 13000 times with a H-index of 66. Her ongoing work focuses on confined ion transport and fluidic memristor.

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IAPME Seminar

Anomalous Ion Transport in Angstrom-scale Two-dimensional Channels

4 December 2025

Prof. Mingzhan WANG
City University of Hong Kong

Venue: N23-1004b
Time: 16:30 - 17:30
Hosted by: Prof. Pengzhan SUN

Abstract

Recent works on 2D nanofuidies have significantly pushed our understanding of the mass transport in the angstrom-scale confinement, including ion, water and gas, In this talk, I will focus on the ion transport in this regime and will highlight the critical role of confinement chemistry to the anomalously enhanced transport of specific ions. Novel asymmetric ion interplay is also observed e.g. cooperative ion transport. In terms of application, I will describe how to use the 2D nanofludics to separate the critical rare earth elements, showing how strikingly these critical elements behave in such 2D confinement.

Biography

Prof. Mingzhan WANG is currently Global Research Assistant Professor at the City University of Hong Kong (CityU) working with Prof. Wenjun ZHANG. He received his B.Eng. degree from the College of Chemistry of Jilin University in 2013. Afterwards, he obtained his Ph.D. from the College of Chemistry and Molecular Engineering of Peking University in 2018. Then he continued his research in the School of Molecular Engineering of the University of Chicago first as postdoctoral scholar and then as Staff Scientist from 2018 to 2024 before coming to CityU.

His research interest and expertise focus on building a sustainable water-energy-materials nexus, covering the controlled synthesis of 2D materials, energy conversion and storage, angstrom-scale nanofluidics, ion transport, desalination, membrane science and separation. He has authored > 40 peer-reviewed publications with a total citation of ~ 3600, among them 16 as first/corresponding authors in Science Advances, Nature Communications, Nature Reviews Chemistry (accepted), Proceedings of the National Academy of Sciences U.S.A., Advanced Materials, Journal of the American Chemical Society, Matter, Nano Letters, ACS Nano etc.

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IAPME Seminar

Integrated Solution for TCM-Based Intelligent Elderly Care and Health-Preserving Platform

5 December 2025

Prof. Xinzui WANG
Jihua Laboratory
Venue: N23-4018
Time: 10:00 - 10:40
Hosted by: Prof. Songnan QU

Abstract

Smart elderly care technology is evolving from decentralized development to an integrated architecture characterized by the collaborative integration of "equipment–data– platform–service". This study focuses on the core technology system of the integrated TCM-based intelligent elderly care and nursing platform solution, elucidates the key technical logic underpinning the fusion of "TCM theory–engineering technology– elderly care service", explores how the multi-modal data fusion mechanism constructs a full-chain technical closed loop of "physio-logical monitoring–intelligent nursing– rehabilitation evaluation–service scheduling", and clarifies the breakthroughs achieved by this solution in the engineering transformation of TCM theory and in enhancing the precision of elderly care services.

Biography

Prof. Xinzui WANG, Ph.D., Researcher and Doctoral Supervisor, is Director of the Institute of Biomedical Engineering Technology and Member of the Party Committee at Jihua Laboratory. He has received multiple honors including selection into the Youth Innovation Promotion Association of the Chinese Academy of Sciences (2015), Foshan City's "Most Beautiful Science and Technology Worker" (2023), and the Second Prize of the Guangdong Provincial Science and Technology Progress Award (2022). He holds several leadership positions in provincial and municipal medical associations related to medical AI, medical-engineering integration, translational medicine, and technology evaluation. In the past five years, he has led over 10 national and provincial-level projects, with extensive engineering experience in biomedical information/image processing and instrument development, focusing on technological advancement and industrialization in these fields.

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IAPME Seminar

The Combination and Development Direction of Mainland Medical Device Industry and New Generation Artificial Intelligence Technology

5 December 2025

Dr. Mingxuan SONG
Suzhou Institute of Biomedical Engineering and Technology

Venue: N23-4018
Time: 11:20 - 12:00
Hosted by: Prof. Songnan QU

Abstract

This presentation aims to provide a systematic analysis of the current state, driving forces, challenges, and future strategic development directions of the deep integration between the medical device industry in Mainland China and new-generation artificial intelligence (AI) technology. Propelled by the "Healthy China 2030" strategy and the national priority given to AI development, the "AI + Medical Device" sector in the mainland is experiencing unprecedented opportunities and has achieved remarkable progress across multiple fronts. Firstly, the presentation will outline the macro context of the medical device industry's development in the mainland. China's vast healthcare market, continuously increasing R&D investment, and increasingly supportive policy framework provide fertile ground for innovation. The National Medical Products Administration (NMPA) has been optimizing the review and approval process for innovative medical devices, creating a "green channel" for the commercialization of AI-powered medical products. Secondly, the presentation will highlight specific application scenarios and achievements of this integration. The fusion has moved from proof-of-concept to large-scale clinical application.

Biography

Dr. Mingxuan SONG, currently serves as the Secretary-General of the CAS Advanced Medical Device Industry Incubation Alliance. He holds the positions of Chairman and General Manager of Suzhou CAS Medical Device Industry Development Co., Ltd.—the only directly invested medical device incubation company under China Holdings Group of the Chinese Academy of Sciences (CAS)—and concurrently acts as President of the Group Corporation of the Suzhou Institute of Biomedical Engineering and Technology (SIBET), CAS. As a Principal Investigator of a sub-project under the National Key R&D Program of China, Dr. Song has been recognized as a Venture Mentor for Jiangsu Provincial Medical Device Professional Incubators and is a core member of the Suzhou Charming Science and Technology Team. He is also an alumnus of the International Technology Partnership Program (ITPC) at the Georgia Institute of Technology, USA, and a certified China International Technology Transfer Manager. In addition, Dr. Song serves as a Standing Council Member of the Bethune Spirit Research Society's Laboratory Medicine Branch. Over more than a decade at SIBET, he has held director and supervisory roles in over ten technology spin-off companies, taking concrete responsibility for technology commercialization, product registration and market launch, clinical validation, investment and financing, and market expansion.

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