澳門大學
UNIVERSIDADE DE MACAU
UNIVERSITY OF MACAU

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 Nature Index; *corresponding author)

1. **Biao Qi**, Yuanzhe Liang, Sen Ding, Dan Fang, Ming Lei, Qian Zhou,* Chao Peng, and **Bingpu Zhou***. Maximizing Signal Capacity via Intrinsic Damped Vibration of Anisotropic Magnetized Micropillars for Wearable Human-Machine Interface. *Chemical Engineering Journal,* 167133 (2025). DOI: 10.1016/j.cej.2025.167133. [2024 IF=13.2]

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Maximizing signal capacity via intrinsic damped vibration of anisotropic magnetized micropillars for wearable human-machine interface

Biao Qi[a], Yuanzhe Liang[a], Sen Ding[a], Dan Fang[a], Ming Lei[a], Qian Zhou[b,*], Chao Peng[c], Bingpu Zhou[a,*]

❖ Research Stories

UM research team developed an anisotropic magnetized micropillar to realize high-capacity human-machine interactions

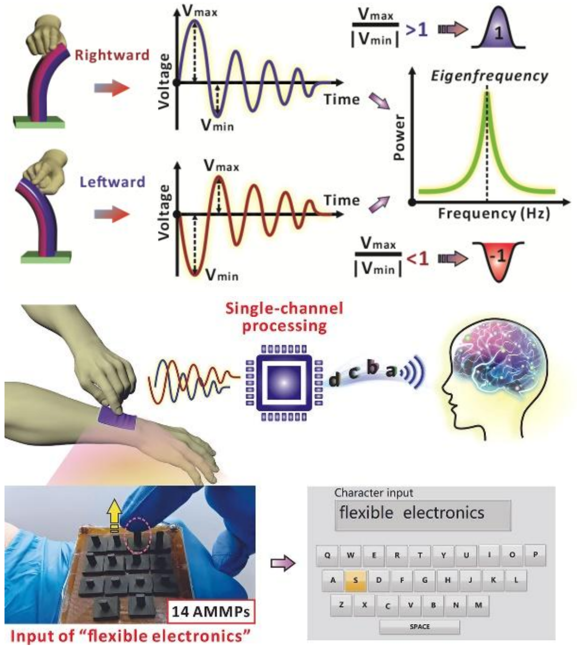
- The fusion of wearable sensors with human-machine interaction systems is revolutionizing our lives in a more intuitive, connected and effective way. However, realizing higher capacity on a single piece is challenging owing to the restrictions from signal differentiation, wiring complexity, and so on.

- Here, the research team reports a wearable HMI interface based on anisotropic magnetized micropillars (AMMPs) that utilize intrinsic polarity and eigenfrequency as dual-parameter sensing. Upon deformation, the intrinsic vibration of AMMPs provides mechanical stimuli to be converted to addressable electrical signals including vibrational direction and eigenfrequency. Guided by cantilever beam model, non-overlapping eigenfrequencies were successfully customized to expand the command library.

- Based on one communication channel, we constructed a wearable HMI interface for high-capacity HMI applications such as password authentication system, intelligent control, and character input. With one coil layer and communication channel, all characters (A-Z) were swiftly generated for typing via integrating 14 AMMPs onto the same interface. We believe that the polarity and eigenfrequency based strategy will facilitate the development of flexible devices in future HMIs, providing high density and concise interaction solutions for wearable systems.

Mr. Biao Qi (祁飈)

Prof. Bingpu Zhou (周冰朴)



Schematic diagram of the sensing principle of anisotropic magnetized micropillars, and demonstration based on a single-channel flexible keyboard.

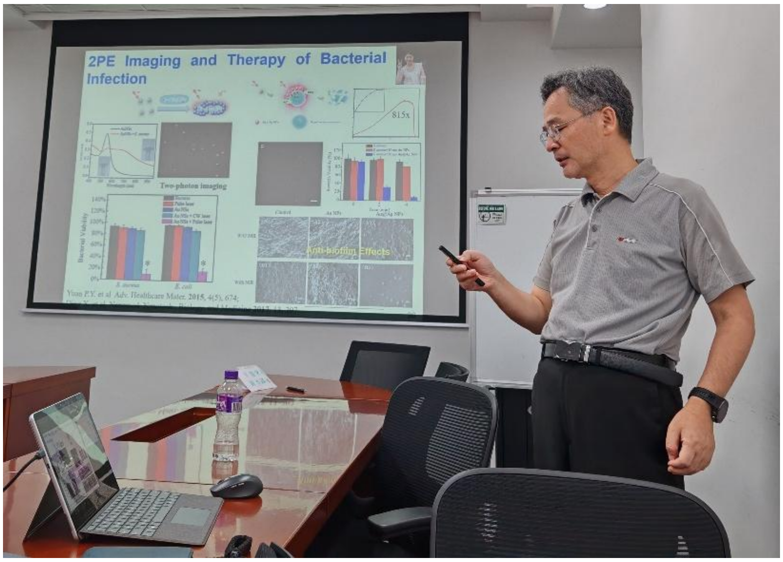
Biao Qi, Yuanzhe Liang, Sen Ding, Dan Fang, Ming Lei, Qian Zhou,* Chao Peng, and **Bingpu Zhou***. Maximizing Signal Capacity via Intrinsic Damped Vibration of Anisotropic Magnetized Micropillars for Wearable Human-Machine Interface. *Chemical Engineering Journal*, 167133 (2025). DOI: 10.1016/j.cej.2025.167133 [2024 IF=13.2]

Prof. Bingpu Zhou is the corresponding author of this study. The first author is Mr. Biao Qi, a Ph.D. student in the IAPME. This work was supported by The Science and Technology Development Fund, Macau SAR (0057/2023/RIB2), Macao Centre for Research and Development in Advanced Materials (0002/2024/TFP), University of Macau (MYRG2024-00090-IAPME) and Hong Kong-Macau Joint Research and Development Fund of Wuyi University (2022WGALH09).

❖ Seminars

On August 25, 2025, we welcomed Prof. Qinghua Xu (徐清華) from the Eastern Institute of Technology, Ningbo, for an insightful seminar titled "Nanocomposite Materials with Enhanced Two-Photon Optical Properties for Biomedical Applications." The event was hosted by Prof. Guichuan Xing, and attracted many participants, including academic members, researchers, and students.

Prof. Xu received his Ph.D. from UC Berkeley in 2001. He joined NUS Chemistry in 2005 and became a tenured Associate Professor in 2011. He joined Eastern Institute Technology, Ningbo, as a Founding Professor in 2024. An internationally recognized expert in optical materials and nanotechnologies, Prof. Xu presented his group's latest research on developing nanomaterials with enhanced two-photon properties through two major strategies. The first strategy is based on fluorescence resonance energy transfer, using conjugated polymers with large two-photon absorption cross-sections. This approach improved the efficiency of two-photon sensing, imaging, and photodynamic therapy by approximately 1000-fold. The second strategy leverages localized surface plasmon resonance from noble metal nanoparticles to enhance optical performance. Prof. Xu also introduced a combined approach that integrates plasmonic enhancement with conjugated polymer nanoparticles for broader biomedical applications.



Following the presentation, participants engaged in a lively Q&A session, with in-depth discussions on two-photon excitation mechanisms, biocompatibility of nanomaterials, single-particle spectroscopy, and their applications in vivo imaging. Our doctoral students and members of nano-optics research group also explored potential collaborations with Prof. Xu in interdisciplinary fields such as optoelectronics, energy, and biomedicine.

This seminar not only strengthened academic ties between the two institutions, but also highlighted our institute's leading role in cutting-edge research at the intersection of advanced materials and biomedical engineering. Prof. Xu's pioneering work offers valuable insights for future collaborative R&D in functional materials and photonic technologies.

❖ Upcoming Events

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IAPME Seminar

Manipulating the Flow of Light & Heat at Nanoscale

12 September 2025

Prof. Jia ZHU
Nanjing University
Venue: N23-3022
Time: 16:00 - 17:00
Hosted by: Prof. Guichuan XING

Abstract

Light and heat are the two most common and widely used energy in the society. Nanostructures with carefully tailored properties can be used to manipulate the flow of light and heat, to enable novel devices and functionalities in an unconventional manner. This presentation will present two examples. The first example is about passive cooling. Radiative cooling which sends heat to space through atmospheric transparency window without any energy consumption, is attracting significant attention. For radiative cooling to achieve high cooling performance, it is ideal to have a selective emitter, with an emissivity dominant in the atmospheric transparency window. However, so far scalable production of radiative cooling materials with selective emissivity has not been realized. Here I will present a hierarchical design for a selective thermal emitter to achieve high performing all-day radiative cooling. Moreover, it is revealed that this hierarchically designed selective thermal emitter shows significant advantage if being applied to alleviate Global Warming or to regulate temperature of the Earth-like planet. The second example is about interfacial solar evaporation. We report that efficient and broad-band plasmonic absorber can be fabricated through a three dimensional self-assembly process. Because of its efficient light absorption and strong field enhancement, it can enable very efficient (>90%) solar vapor generations. Inspired by the transpiration process in plants, we report an artificial transpiration device with a unique design of two dimensional water path. The energy transfer efficiency of this artificial transpiration device is independent of water quantity and can be achieved without extra optical or thermal supporting systems, therefore significantly improve the scalability and feasibility of this technology. At the end, we would like to demonstrate that this type of interfacial solar vapor generations can have direct implications in various fields such as solar desalination, zero liquid discharge, sterilization and lithium extraction.

Biography

Prof. Jia ZHU is a Professor at Nanjing University, a fellow of MRS, Optica and RSC. His research focuses on manipulating light and heat at nanoscale. As a Highly Cited Researcher of Clarivate, he has published over 170 papers, with over 30,000 citations, on prestigious journals such as Nature, Science, N/S/C series, NSR, Advanced Materials. He also serves as the executive editor of Nanophotonics and the editorial board member of Advanced Photonics. Recent honors include: The Xplorer Prize, NSFC Young Investigator Award, OSA Young Investigator Award, Tan Kah Kee Young Scientist Award, MIT Technology Review Innovators Under 35.

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