ADVANCED SUMMIT ICMIA BEIJING 2026

# 国际先进材料与智能制造大会 + 人工智能 2026

## 暨北京国际学术交流季

Wiley Advanced Summit (Beijing) & International Conference on Advanced Materials and Intelligent Manufacturing + AI 2026 (ICMIA 2026) & Beijing International Academic Season

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AI 赋能 · 材料革新 · 智造未来

AI EMPOWERMENT · MATERIALS INNOVATION · INTELLIGENT MANUFACTURING

# 会议手册

## Program Book

11 月 6 日 – 9 日

6 – 9 November 2026

北京 · 顺义

Shunyi, Beijing

中关村论坛 2026 ZGC FORUM 系列活动 Regular Activities

BAS 北京国际学术交流季 BEIJING INTERNATIONAL ACADEMIC SEASON

Chinese Association of Development Strategy Studies

Advanced Materials and Intelligent Manufacturing Strategy Committee

WILEY ADVANCED

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Wiley Advanced Summit (Beijing)

# 国际先进材料与智能制造大会+人工智能 2026

## 暨北京国际学术交流季

Wiley Advanced Summit (Beijing) & International Conference on Advanced Materials and Intelligent Manufacturing + AI 2026 (ICMIA 2026) & Beijing International Academic Season

**AI 赋能 · 材料革新 · 智造未来**

## 会议介绍 Conference Introduction

本次大会以“AI 赋能·材料革新·智造未来”为核心主题，以人工智能为核心驱动力，构建“国际顶刊 Summit + 平行分论坛 + 特色环节 + 配套活动”的学术体系，聚焦 AI 与先进材料、智能制造的融合应用，搭建高端国际学术交流平台，促进产学研融合与人才培养。大会将举办国际顶刊 Summit——Advanced Materials 期刊中国首秀，设院士主旨报告、顶刊主编圆桌论坛、七个平行分论坛、超导材料与二维材料两个专题论坛，以及研究生论坛、墙报交流、Wiley 编辑面对面等特色环节。本次大会是“中关村论坛”系列活动之一，也是“北京国际学术交流季”的重要组成部分。

## 组织单位 Organization

| | |
|---|---|
| **主办单位** | 中国发展战略学研究会<br>约翰威立国际出版集团（Wiley） |
| **承办单位** | 中国发展战略学研究会先进材料与智能制造战略专业委员会 |
| **协办单位** | 中国科学院北京纳米能源与系统研究所<br>中国电工技术学会超导应用技术专业委员会<br>北京数蜂科技有限公司<br>清华大学材料学院<br>中国矿业大学（北京）<br>北京大学医学部国际合作处<br>中南大学湘雅医院<br>天津大学材料学院 |

## 大会组织架构 Committees

### 大会主席 Conference Chairs

王中林（中国科学院北京纳米能源与系统研究所所长）、张锦（北京大学常务副校长）、
雒建斌（清华大学机械工程学院院长）、Sanjay Mathur（德国科隆大学无机化学研究所所长）、林元华（清华大学材料学院院长）

### 大会学术委员会 Academic Committee

**主任：**刘忠范、南策文、李和兴、Rodrigo Martins

**副主任：**陈军、范智勇、Gehan A.J. Amaratunga、葛世荣、Lars Samuelson、罗仙平、Oliver G. Schmidt、潘教峰、王钻开、徐政和、张建民、张立群、张平祥、郑泉水

**委员：**Chengkuo Lee、邓意达、杜亚平、Eun Soo Park、高标、高召顺、宫勇吉、古宏伟、郭海中、郭少军、郭耘、Henk Busscher、Herbert Huppert、侯新梅、蒋晓华、焦淑红、赖超、兰司、李昺、李舟、李致朋、刘锴、刘遵峰、Lototskyy Mykhaylo、吕瑞涛、马建民、麦文杰、米绪军、Miso Kim、聂双喜、Patrik Schmuki、秦勇、孙志刚、Santi Maensiri、Satoshi Wada、Soo Whon Lee、田明亮、Unemoto Atsushi、万厚钊、闻海虎、王荣明、王一菁、文震、吴德峰、吴震、徐晓光、杨建平、杨维清、Yoshio Bando、游才印、于广华、余靓、张道海、张俊英、张深根、张铁锐、张莹莹、张加涛、赵立东、赵相玉、郑东宁、周家东、朱铁军（按姓氏首字母排序）

## 大会组织委员会 Organizing Committee

**主任：**钱九红、Louisa Flintoft、张莫依、翟俊宜

**副主任：**李健、马雯、许杰

**委员：**崔曜、丁锡锋、段小川、范凤茹、高明、古兴兴、郭恒宇、韩卫华、韩卫忠、胡彬、胡又凡、扈艳红、贾喆、李海亮、李修函、林剑云、刘虎、刘华军、刘宏宇、刘光、刘瑞平、刘涛、刘向文、刘新华、卢周广、鲁仰辉、罗聃、马儒军、马振辉、潘勤鹤、齐红宇、邱清泉、王华、王欢、王杰、王丽、王丽熙、王笑楠、王兆娜、王国胜、奚宝娟、徐敏义、徐秀兰、杨柳春、杨如森、杨远飞、衣芳、于庆河、于永生、詹望成、张一波、张智宏、赵雷、郑海务、郑金星、周遥、朱贺（按姓氏首字母排序）

## 大会秘书处 Secretariat

**秘书长：**钱九红　　**副秘书长：**林剑云　　**秘书：**边璐璐、Grace Hao

**2026 年 11 月 6 日–9 日 · 中国·北京·顺义区·君和豪生酒店 · 线下千人（青年学者 400 人）· 线上 2 万+人次**

**会议网站** Conference Website

**官方微信公众号** Official WeChat Account



## Zhong Lin Wang

Director, Beijing Institute of Nanoenergy and Nanosystems, Chinese Academy of Sciences; Regents' Professor and Hightower Chair (Emeritus), Georgia Institute of Technology, USA

### BIOGRAPHY

Dr. Zhong Lin Wang is a preeminent physicist and materials scientist whose groundbreaking work has revolutionized the fields of nanotechnology, energy harvesting, and self-powered systems. He currently serves as the Director of the Beijing Institute of Nanoenergy and Nanosystems and holds the distinguished titles of Regents' Professor and Hightower Chair (Emeritus) at the Georgia Institute of Technology. Dr. Wang is widely recognized as the pioneer of the nanogenerator field, which has enabled advancements in distributed energy, self-powered sensors, and large-scale blue energy. Additionally, he coined and developed the fields of piezotronics and piezo-phototronics, which have significant implications for third-generation semiconductors.

Dr. Wang's scientific impact is unparalleled. Among 230,000 scientists across all fields worldwide (Top 2%) as ranked by Elsevier and Stanford, he is ranked #1 simultaneously for career-long scientific impact and single-year scientific impact consecutively from 2019–2025. He is also ranked #1 respectively in Materials Science and Nanotechnology. His research has garnered over 564,000 citations on Google Scholar, with an extraordinary h-index of 355, underscoring his immense influence and contributions to science.

Throughout his illustrious career, Dr. Wang has received numerous prestigious awards, including the Global Energy Prize (2023), the Albert Einstein World Award of Science (2019), the ENI Award in Energy Frontiers (2018), the James C. McGroddy Prize in New Materials from the American Physical Society (2014), and the MRS Medal from the Materials Research Society (2011). His groundbreaking work has earned him memberships and fellowships in some of the world's most esteemed scientific academies, including the UK Royal Academy of Engineering, the Chinese Academy of Sciences, the US National Academy of Inventors, the European Academy of Sciences, the Korea Academy of Science and Technology (as a foreign member), and the Canadian Academy of Engineering (as an International Fellow).

Dr. Wang's pioneering contributions to nanogenerators, piezotronics, and self-powered systems have not only advanced fundamental science but also paved the way for transformative technologies in energy harvesting, sensing, and semiconductor development. His exceptional scientific impact, numerous accolades, and leadership in the global scientific community underscore his status as one of the most influential materials scientists of our time.



## Jin Zhang

Academician of the Chinese Academy of Sciences; Executive Vice President, Peking University, China

### BIOGRAPHY

Jin Zhang is Academician of the Chinese Academy of Sciences and Executive Vice President of Peking University. His research focuses on spectroscopic analysis of nanomaterials, in particular surface-enhanced Raman spectroscopy, and on the design and preparation of functional nanostructured optoelectronic materials for sensing, imaging and energy applications.

He has published extensively in leading international journals and has received major honors including the National Science Fund for Distinguished Young Scholars and national science and technology awards of China. At Peking University he has held multiple leadership roles, promoting interdisciplinary research, talent cultivation and international cooperation in chemistry and materials science.



## Jianbin Luo

Academician of the Chinese Academy of Sciences; Dean of the School of Mechanical Engineering, Tsinghua University, China

### BIOGRAPHY

Jianbin Luo is Academician of the Chinese Academy of Sciences and Dean of the School of Mechanical Engineering at Tsinghua University. He is a leading scholar in tribology who pioneered systematic studies of thin-film lubrication and superlubricity, establishing new regimes of ultra-low friction and wear and guiding their applications in precision manufacturing and advanced equipment.

He has served as Director of the State Key Laboratory of Tribology in Advanced Equipment at Tsinghua University, has published prolifically in leading international journals, and has received major honors, among them the International Award of the Society of Tribologists and Lubrication Engineers (STLE) and national awards for science and technology of China.



## Sanjay Mathur

Member of Academia Europaea; Professor and Director, Institute of Inorganic Chemistry, University of Cologne, Germany

### BIOGRAPHY

Sanjay Mathur is Professor and Director of the Institute of Inorganic Chemistry at the University of Cologne, Germany, and a member of Academia Europaea. His research bridges molecular chemistry and materials engineering, focusing on chemical nanotechnologies and the rational design of functional nanostructures for energy conversion, environmental sensing and biomedical applications.

He has authored several hundred publications and holds numerous patents, and has served in leadership roles in international materials societies, including the presidency of the European Ceramic Society. He has received multiple international awards for his contributions to materials chemistry and chemical nanotechnology.



## Yuanhua Lin

Academician of the Chinese Academy of Sciences; Dean of the School of Materials Science and Engineering, Tsinghua University, China

### BIOGRAPHY

Yuanhua Lin is Academician of the Chinese Academy of Sciences and Dean of the School of Materials Science and Engineering at Tsinghua University. His research focuses on functional ceramics, including dielectric energy-storage ceramics, piezoelectric and thermoelectric materials, addressing the synthesis-structure-property relationships that underpin capacitors, sensors and solid-state energy conversion devices.

He has published extensively in leading international journals and has received important national and ministerial-level awards for his contributions to materials science and engineering.

# ICMIA 2026 · International Conference on Advanced Materials and Intelligent Manufacturing

Conference Overview & Master Schedule | November 6–8, 2026 · Beijing, China

| No. | Type | Session | Theme | Chairs | Date & Time | Venue |
|---|---|---|---|---|---|---|
| 1 | Plenary | Opening Ceremony & Plenary Sessions | Opening ceremony · Launch of the 3rd Wiley Star Scientist Award · Advanced Leaders Forum roundtable (AI-Powered Research and Innovation) · Plenary Talks 1–10 (Advanced City Launch on Nov 8) | Opening: Jian Li (Wiley)<br>Plenary chairs: Esther Levy / Richard Murray / Joern Ritterbusch<br>Roundtable chair: Jing Li (Wiley); panelists: Zhong Lin Wang, Hai-Hu Wen, Francesca Santoro, Ilia Valov, Allyn Molina<br>Launch: Shirley Wang / Jiaqi Li | Nov 7 (Sat) 08:30–12:05<br>Nov 8 (Sun) 08:30–12:00 | Haosheng Hall (1F) |
| 2 | Symposium | Parallel Symposium 01 | Advanced Materials and AI Empowerment | Longfei Wang (Beijing Institute of Nanoenergy and Nanosystems, CAS)<br>Ke Liu (Peking University)<br>Fei Wu (Chongqing University)<br>Libo Chen (Uppsala University, Sweden)<br>Lixi Wang (Nanjing Tech University)<br>Esther Levy (Editor-in-Chief, Advanced Materials · Wiley) | Nov 7–8 (Sat–Sun)<br>13:30–18:30 daily | Haosheng Hall A (1F) |
| 3 | Symposium | Parallel Symposium 02 | Intelligent Manufacturing and Process Innovation | Wenbo Ding (Tsinghua Shenzhen International Graduate School)<br>Renyun Zhang (Mid Sweden University; Beijing Institute of Nanoenergy and Nanosystems, CAS)<br>Xinjun Liu (Tsinghua University)<br>Yuhong Liu (Tsinghua University)<br>Zhe Chen (Zhejiang University)<br>Rusen Yang (Xidian University)<br>Xiaoqiang Lu (Nanyang Technological University, Singapore)<br>Richard Murray (Wiley · Advanced portfolio) | Nov 7–8 (Sat–Sun)<br>13:30–17:15 daily | Lanyue Pavilion (2F) |
| 4 | Symposium | Parallel Symposium 03 | Intelligent Sensing and New-Generation AI | Junyi Zhai (Beijing Institute of Nanoenergy and Nanosystems, CAS)<br>Zhen Wen (Soochow University)<br>Gulnur Kalimuldina (Nazarbayev University, Kazakhstan)<br>Tinghai Cheng (Beijing Institute of Nanoenergy and Nanosystems, CAS)<br>Joern Ritterbusch (Editor-in-Chief, Advanced Functional Materials · Wiley) | Nov 7–8 (Sat–Sun)<br>13:00–18:30 daily | Haosheng Hall C (1F) |
| 5 | Symposium | Parallel Symposium 04 | Medical–Engineering Interdisciplinary Research and Intelligent Materials & Devices | Yanglong Hou (Sun Yat-sen University)<br>Sang-Woo Kim (Yonsei University, Korea)<br>Dan Luo (Beijing Institute of Nanoenergy and Nanosystems, CAS)<br>Jing Yu (Zhejiang University of Technology)<br>Yan Liu (Peking University School of Stomatology)<br>Partha Pratim Pal (Deputy Editor, Chemistry – An Asian Journal · Wiley)<br>Tao Yang (Editor, Advanced Science / Advanced Materials · Wiley)<br>Xi Wen (Editor-in-Chief, Small Methods · Wiley) | Nov 7–8 (Sat–Sun)<br>13:30–18:35 daily | Junhe Hall (1F) |

| No. | Type | Session | Theme | Chairs | Date & Time | Venue |
|---|---|---|---|---|---|---|
| 6 | Symposium | Parallel Symposia 05A & 05B | New Energy Materials and Green Manufacturing | Shuhui Sun (INRS, Canada)<br>Shaojun Guo (Peking University)<br>Xinmei Hou (University of Science and Technology Beijing)<br>Jianmin Ma (Tiangong University)<br>Shuhong Jiao (University of Science and Technology of China)<br>Hua Wang (Beihang University)<br>Chao Lai (Jiangsu Normal University)<br>Zhenhui Ma (Beijing Technology and Business University)<br>Till von Graberg (Editor-in-Chief, Advanced Energy Materials · Wiley) | Nov 7–8 (Sat–Sun)<br>13:30–17:00 daily | 05A Laoshan Hall (1F)<br>05B Xiangshan Hall (1F) |
| 7 | Symposium | Parallel Symposium 06 | AI Empowering Science Communication and Academic Publishing | Jian Li (Senior Director, Physical Sciences Editorial, Wiley Asia Pacific)<br>Jiuhong Qian (Vice President, China Periodicals Association; General Manager & Editor-in-Chief, Youke Journal Publishing (Beijing) Co., Ltd.) | Nov 7–8 (Sat–Sun)<br>14:00–16:30 daily | Yingyue Pavilion (2F) |
| 8 | Symposium | Parallel Symposium 07 | Graduate Student Forum | Weipeng Wang (Tsinghua University)<br>Ruqiang Zou (Peking University)<br>Xiaoli Xi (Beijing University of Technology)<br>Haobin Zhang (Beijing University of Chemical Technology)<br>Xingwang Cheng (Beijing Institute of Technology)<br>Chunnian He (Tianjin University)<br>Guocheng Lv (China University of Geosciences, Beijing)<br>Qingliang Liao (University of Science and Technology Beijing)<br>Lidong Zhao (Beihang University) | Nov 6 (Fri)<br>13:00–18:25 | Junhe Hall (1F) |
| 9 | Special Topic | Special Topic Forum S01 | Superconducting Materials | Haihu Wen (Nanjing University)<br>Jinxing Zheng (Hefei Institutes of Physical Science, CAS)<br>Huajun Liu (Hefei Institutes of Physical Science, CAS)<br>Qingquan Qiu (Institute of Electrical Engineering, CAS)<br>Nadezda Panarina (Editor-in-Chief, Nanophotonics · Wiley) | Nov 7–8 (Sat–Sun)<br>14:00–17:35 daily | Kuiyue Pavilion (2F) |
| 10 | Special Topic | Special Topic Forum S02 | 2D Materials | Jiadong Zhou (Beijing Institute of Technology)<br>Rongming Wang (University of Science and Technology Beijing)<br>Xiaoxu Zhao (Peking University)<br>Jinshui Miao (Shanghai Institute of Technical Physics, CAS)<br>Taotao Li (Nanjing University)<br>Yao Zhou (Beijing Institute of Technology)<br>Hu Liu (Qinghai Institute of Salt Lakes, CAS)<br>Ziyi Guo (Deputy Editor, Advanced Science · Wiley) | Nov 7–8 (Sat–Sun)<br>13:30–18:40 daily | Fengye Hall (2F) |

| No. | Type | Session | Theme | Chairs | Date & Time | Venue |
|---|---|---|---|---|---|---|
| 11 | Special Topic | National Materials Symposium | National Materials journal session (journal introduction + invited talks) | Jin Zhang (Peking University)<br>Shaojun Guo (Peking University) | Nov 7 (Sat)<br>14:00–17:30 | Taishan Hall (1F) |
| 12 | Journal Event | SmartSys Editorial Board Meeting & Symposium | Journal progress report, editorial board discussion and impact plan, awards for outstanding young editorial board members | Zhong Lin Wang (Editor-in-Chief, SmartSys · Beijing Institute of Nanoenergy and Nanosystems, CAS)<br>Junyi Zhai (Associate Editor, SmartSys · Beijing Institute of Nanoenergy and Nanosystems, CAS) | Nov 8 (Sun)<br>15:30–17:00 | Taishan Hall (1F) |
| 13 | Side Event | Wiley Meet the Editors: One-on-One Sessions | 15-minute one-on-one meetings with Wiley editors; advance abstract submission required for booking | Organized by Wiley<br>13 editors: Esther Levy, Joern Ritterbusch, Till Graberg, Richard Murray, Nadezda Panarina, Partha Pal, 梁多多, 翁博, 温茜, 李佳琪, 杨涛, 祖萌 (Alick Zu), 郭子艺 | Nov 7–8 (Sat–Sun)<br>15:00–17:00 daily | Songshan Hall |
| 14 | Poster | Poster Presentation (P-01 – P-56) | 56 posters, numbered P-01–P-56 and displayed in 7 thematic zones | Presenters at their boards (no fixed chair) | Nov 6 16:30–18:00<br>Nov 7 15:00–17:00<br>Nov 8 15:00–17:00 | Poster Area (TBD) |
| 15 | Plenary | Registration | Delegate check-in and collection of conference materials | Conference Secretariat | Nov 6 (Fri)<br>All day | Registration Desk |
| 16 | Plenary | Conference Dinner & General Assembly | Conference dinner; General Assembly of the Committee of Advanced Materials and Intelligent Manufacturing, China Society of Development Strategy | Committee Secretariat | Nov 7 (Sat)<br>Dinner 19:00<br>Assembly 20:30–21:30 | Haosheng Hall<br>Junhe Hall |
| 17 | Side Event | Advanced Journal Campus Tour · Tsinghua University | Wiley's Advanced Materials journal portfolio visits the School of Materials Science and Engineering, Tsinghua University — editorial talks, author sharing and roundtable with faculty and students; a side event of ICMIA 2026 | Organized by Wiley · School of Materials Science and Engineering, Tsinghua University | Nov 9 (Mon)<br>All day (time TBD) | School of Materials Science and Engineering, Tsinghua University |

# Conference at a Glance

| Date | Morning | Afternoon | Evening |
|---|---|---|---|
| Nov 6 (Fri) | Registration all day (Registration Desk) | Graduate Student Forum (Symposium 07) 13:00–18:25 · Junhe Hall (1F)<br>Poster Session I 16:30–18:00 · Poster Area | — |
| Nov 7 (Sat) | Plenary Session I 08:30–12:05 · Haosheng Hall (1F)<br>incl. Advanced Leaders Forum: AI-Powered Research and Innovation<br>Launch of the 3rd Wiley Star Scientist Award | Parallel Symposia 01–06, Special Topic Forums S01 / S02, National Materials (13:00–18:40)<br>Poster Session II 15:00–17:00 · Poster Area<br>Wiley Meet the Editors 15:00–17:00 · Songshan Hall | Conference Dinner<br>Committee General Assembly (Committee of Advanced Materials and Intelligent Manufacturing) |
| Nov 8 (Sun) | Plenary Session II 08:30–12:00 · Haosheng Hall (1F)<br>incl. Advanced City Launch | Parallel Symposia 01–06, Special Topic Forums S01 / S02, SmartSys<br>Editorial Board Meeting & Symposium (13:30–18:40)<br>Poster Session III 15:00–17:00 · Poster Area<br>Wiley Meet the Editors 15:00–17:00 · Songshan Hall | — |
| Nov 9 (Mon) | Advanced Journal Campus Tour · Tsinghua University<br>All day, exact time TBD | (as left, all-day event) | — |

# Master Schedule by Day

| Date | Time | Event | Venue |
|---|---|---|---|
| Nov 6 (Fri) | All day | Registration | Registration Desk |
| | 13:00–18:25 | Symposium 07 · Graduate Student Forum (30 talks in one day) | Junhe Hall (1F) |
| | 16:30–18:00 | Poster Session I (P-01–P-56) | Poster Area |
| Nov 7 (Sat) | 08:30–12:05 | Opening Ceremony & Plenary Session I | Haosheng Hall (1F) |
| | 13:00–18:30 | Symposium 03 · Intelligent Sensing and New-Generation AI | Haosheng Hall C (1F) |
| | 13:30–17:15 | Symposium 02 · Intelligent Manufacturing and Process Innovation | Lanyue Pavilion (2F) |
| | 13:30–18:30 | Symposium 01 · Advanced Materials and AI Empowerment | Haosheng Hall A (1F) |
| | 13:30–17:00 | Symposia 05A/05B · New Energy Materials and Green Manufacturing | Laoshan / Xiangshan Hall (1F) |
| | 13:30–18:35 | Symposium 04 · Medical–Engineering Interdisciplinary Research | Junhe Hall (1F) |
| | 13:30–18:40 | Special Topic Forum S02 · 2D Materials | Fengye Hall (2F) |
| | 13:50–17:35 | Special Topic Forum S01 · Superconducting Materials (society leadership remarks at 13:50) | Kuiyue Pavilion (2F) |
| | 14:00–16:30 | Symposium 06 · AI Empowering Science Communication and Academic Publishing | Yingyue Pavilion (2F) |
| | 14:00–17:30 | National Materials Symposium | Taishan Hall (1F) |
| | 15:00–17:00 | Poster Session II | Poster Area |
| | 15:00–17:00 | Wiley Meet the Editors | Songshan Hall |
| | Evening | Conference Dinner & General Assembly | Dinner 19:00 · Haosheng Hall<br>Assembly 20:30–21:30 · Junhe Hall |
| Nov 8 (Sun) | 08:30–12:00 | Plenary Session II | Haosheng Hall (1F) |
| | 13:00–18:30 | Symposium 03 · Intelligent Sensing and New-Generation AI | Haosheng Hall C (1F) |
| | 13:30–17:15 | Symposium 02 · Intelligent Manufacturing and Process Innovation | Lanyue Pavilion (2F) |
| | 13:30–18:30 | Symposium 01 · Advanced Materials and AI Empowerment | Haosheng Hall A (1F) |
| | 13:30–17:00 | Symposia 05A/05B · New Energy Materials and Green Manufacturing | Laoshan / Xiangshan Hall (1F) |
| | 13:30–18:35 | Symposium 04 · Medical–Engineering Interdisciplinary Research | Junhe Hall (1F) |
| | 13:30–18:40 | Special Topic Forum S02 · 2D Materials | Fengye Hall (2F) |
| | 14:00–17:35 | Special Topic Forum S01 · Superconducting Materials | Kuiyue Pavilion (2F) |
| | 14:00–16:30 | Symposium 06 · AI Empowering Science Communication and Academic Publishing | Yingyue Pavilion (2F) |
| | 15:00–17:00 | Poster Session III | Poster Area |
| | 15:00–17:00 | Wiley Meet the Editors | Songshan Hall |
| | 15:30–17:00 | SmartSys Editorial Board Meeting & Symposium | Taishan Hall (1F) |
| Nov 9 (Mon) | All day | Advanced Journal Campus Tour · Tsinghua University | School of Materials Science and Engineering, Tsinghua University |

# ICMIA 2026 国际先进材料与智能制造大会 · 会议总表

International Conference on Advanced Materials and Intelligent Manufacturing | 2026 年 11 月 6–8 日

| 序号 | 类别 | 名称 Name | 会议主题 Theme | 分会主席 / 主持 Chairs | 时间 Date & Time | 场地 Venue |
|---|---|---|---|---|---|---|
| 1 | 全体大会 | 大会开幕式及大会报告<br>Opening Ceremony & Plenary Sessions | 开幕式、第三届 Wiley Star Scientist Award 启动仪式、Advanced Leaders Forum 圆桌讨论（AI-Powered Research and Innovation）、大会报告 1–10（11 月 8 日含 Advanced City 启动仪式） | 开幕式：李健 Jian Li（Wiley）<br>大会报告主持：Esther Levy / Richard Murray / Joern Ritterbusch<br>圆桌主持：李晶 Jing Li（Wiley）；圆桌嘉宾：王中林、闻海虎、Francesca Santoro、Ilia Valov、Allyn Molina<br>启动仪式：Shirley Wang / 李佳琪 Jiaqi Li | 11 月 7 日（周六）08:30–12:05<br>11 月 8 日（周日）08:30–12:00 | 豪生厅（1F）<br>Haosheng Hall |
| 2 | 分论坛 | 分论坛一<br>Parallel Symposium 01 | 先进材料与人工智能赋能<br>Advanced Materials and AI Empowerment | 王龙飞 Longfei Wang（中科院北京纳米能源所）<br>刘珂 Ke Liu（北京大学）<br>吴飞 Fei Wu（重庆大学）<br>陈立博 Libo Chen（瑞典乌普萨拉大学）<br>王丽熙 Lixi Wang（南京工业大学）<br>Esther Levy（Advanced Materials 主编 · Wiley） | 11 月 7–8 日（周六–周日）<br>每日 13:30–18:30 | 豪生厅 A（1F）<br>Haosheng Hall A |
| 3 | 分论坛 | 分论坛二<br>Parallel Symposium 02 | 智能制造与工艺创新<br>Intelligent Manufacturing and Process Innovation | 丁文伯 Wenbo Ding（清华大学深圳国际研究生院）<br>张仁云 Renyun Zhang（瑞典中部大学；中科院北京纳米能源所）<br>刘辛军 Xinjun Liu（清华大学）<br>刘宇宏 Yuhong Liu（清华大学）<br>陈哲 Zhe Chen（浙江大学）<br>杨如森 Rusen Yang（西安电子科技大学）<br>陆孝强 Xiaoqiang Lu（新加坡南洋理工大学）<br>Richard Murray（Wiley · Advanced 系列期刊） | 11 月 7–8 日（周六–周日）<br>每日 13:30–17:15 | 兰月阁（2F）<br>Lanyue Pavilion |
| 4 | 分论坛 | 分论坛三<br>Parallel Symposium 03 | 智能传感与新一代人工智能<br>Intelligent Sensing and New-Generation AI | 翟俊宜 Junyi Zhai（中科院北京纳米能源所）<br>文震 Zhen Wen（苏州大学）<br>Gulnur Kalimuldina（哈萨克斯坦纳扎尔巴耶夫大学）<br>程廷海 Tinghai Cheng（中科院北京纳米能源所）<br>Joern Ritterbusch（Advanced Functional Materials 主编 · Wiley） | 11 月 7–8 日（周六–周日）<br>每日 13:00–18:30 | 豪生厅 C（1F）<br>Haosheng Hall C |

| 序号 | 类别 | 名称 Name | 会议主题 Theme | 分会主席 / 主持 Chairs | 时间 Date & Time | 场地 Venue |
|---|---|---|---|---|---|---|
| 5 | 分论坛 | 分论坛四<br>Parallel Symposium 04 | 医工交叉与智能材料器件<br>Medical-Engineering Interdisciplinary Research and Intelligent Materials & Devices | 侯仰龙 Yanglong Hou（中山大学）<br>Sang-Woo Kim（韩国延世大学）<br>罗聃 Dan Luo（中科院北京纳米能源所）<br>余靓 Jing Yu（浙江工业大学）<br>刘燕 Yan Liu（北京大学口腔医学院）<br>Partha Pratim Pal（Chemistry – An Asian Journal 副主编 · Wiley）<br>杨涛 Tao Yang（Advanced Science / Advanced Materials 编辑 · Wiley）<br>温茜 Xi Wen（Small Methods 主编 · Wiley） | 11 月 7–8 日（周六–周日）<br>每日 13:30–18:35 | 君和厅（1F）<br>Junhe Hall |
| 6 | 分论坛 | 分论坛五（05A / 05B 两个分会场）<br>Parallel Symposia 05A & 05B | 新能源材料与绿色制造<br>New Energy Materials and Green Manufacturing | 孙书会 Shuhui Sun（加拿大 INRS）<br>郭少军 Shaojun Guo（北京大学）<br>侯新梅 Xinmei Hou（北京科技大学）<br>马建民 Jianmin Ma（天津工业大学）<br>焦淑红 Shuhong Jiao（中国科学技术大学）<br>王华 Hua Wang（北京航空航天大学）<br>赖超 Chao Lai（江苏师范大学）<br>马振辉 Zhenhui Ma（北京工商大学）<br>Till von Graberg（Advanced Energy Materials 主编 · Wiley） | 11 月 7–8 日（周六–周日）<br>每日 13:30–17:00 | 05A 崂山厅（1F）<br>05B 香山厅（1F） |
| 7 | 分论坛 | 分论坛六<br>Parallel Symposium 06 | AI 赋能科学传播与学术出版<br>AI Empowering Science Communication and Academic Publishing | 李健 Jian Li（Wiley 亚太区物理科学编辑总监）<br>钱九红 Jiuhong Qian（中国期刊协会副会长；有科期刊出版（北京）有限公司总经理、主编） | 11 月 7–8 日（周六–周日）<br>每日 14:00–16:30 | 樱月阁（2F）<br>Yingyue Pavilion |
| 8 | 分论坛 | 分论坛七<br>Parallel Symposium 07 | 研究生论坛<br>Graduate Student Forum | 王炜鹏 Weipeng Wang（清华大学）<br>邹如强 Ruqiang Zou（北京大学）<br>席晓丽 Xiaoli Xi（北京工业大学）<br>张好斌 Haobin Zhang（北京化工大学）<br>程兴旺 Xingwang Cheng（北京理工大学）<br>何春年 Chunnian He（天津大学）<br>吕国诚 Guocheng Lv（中国地质大学（北京））<br>廖庆亮 Qingliang Liao（北京科技大学）<br>赵立东 Lidong Zhao（北京航空航天大学） | 11 月 6 日（周五）<br>13:00–18:25 | 君和厅（1F）<br>Junhe Hall |
| 9 | 专题论坛 | 专题论坛 S01<br>Special Topic Forum S01 | 超导材料<br>Superconducting Materials | 闻海虎 Haihu Wen（南京大学）<br>郑金星 Jinxing Zheng（中科院合肥物质科学研究院）<br>刘华军 Huajun Liu（中科院合肥物质科学研究院）<br>邱清泉 Qingquan Qiu（中科院电工研究所）<br>Nadezda Panarina（Nanophotonics 主编 · Wiley） | 11 月 7–8 日（周六–周日）<br>每日 14:00–17:35 | 葵月阁（2F）<br>Kuiyue Pavilion |

| 序号 | 类别 | 名称 Name | 会议主题 Theme | 分会主席 / 主持 Chairs | 时间 Date & Time | 场地 Venue |
|---|---|---|---|---|---|---|
| 10 | 专题论坛 | 专题论坛 S02<br>Special Topic Forum S02 | 二维材料<br>2D Materials | 周家东 Jiadong Zhou（北京理工大学）<br>王荣明 Rongming Wang（北京科技大学）<br>赵晓续 Xiaoxu Zhao（北京大学）<br>苗金水 Jinshui Miao（中科院上海技术物理研究所）<br>李涛涛 Taotao Li（南京大学）<br>周遥 Yao Zhou（北京理工大学）<br>刘虎 Hu Liu（中科院青海盐湖研究所）<br>郭子艺 Ziyi Guo（Advanced Science 副主编 · Wiley） | 11 月 7–8 日（周六–周日）<br>每日 13:30–18:40 | 枫叶厅（2F）<br>Fengye Hall |
| 11 | 专题论坛 | National Materials 专题论坛<br>National Materials Symposium | National Materials 期刊专题论坛（期刊介绍 + 特邀报告） | 张锦 Jin Zhang（北京大学）<br>郭少军 Shaojun Guo（北京大学） | 11 月 7 日（周六）<br>14:00–17:30 | 泰山厅（1F）<br>Taishan Hall |
| 12 | 期刊活动 | SmartSys 编委会暨研讨会<br>SmartSys Editorial Board and Symposium | 期刊进展报告、编委研讨与影响力提升计划、优秀青年编委颁奖 | 王中林 Zhong Lin Wang（SmartSys 主编 · 中科院北京纳米能源所）<br>翟俊宜 Junyi Zhai（SmartSys 副主编 · 中科院北京纳米能源所） | 11 月 8 日（周日）<br>15:30–17:00 | 泰山厅（1F）<br>Taishan Hall |
| 13 | 配套活动 | Wiley 编辑面对面（一对一咨询）<br>Wiley Meet the Editors: One-on-One Sessions | 与 Wiley 编辑一对一交流（每人 15 分钟），需提前提交摘要预约 | 组织方：Wiley<br>参与编辑 13 位：Esther Levy、Joern Ritterbusch、Till Graberg、Richard Murray、Nadezda Panarina、Partha Pal、梁多多、翁博、温茜、李佳琪、杨涛、祖萌、郭子艺 | 11 月 7–8 日（周六–周日）<br>每日 15:00–17:00 | 嵩山厅<br>Songshan Hall |
| 14 | 墙报 | 墙报展示与交流<br>Poster Presentation (P-01 – P-56) | 56 个墙报，编号 P-01–P-56，按 7 个主题分区张贴 | 墙报作者现场交流（无固定主持） | 11 月 6 日 16:30–18:00<br>11 月 7 日 15:00–17:00<br>11 月 8 日 15:00–17:00 | 墙报区<br>Poster Area（待定） |
| 15 | 全体大会 | 注册报到<br>Registration | 参会代表注册、领取资料 | 大会秘书处 | 11 月 6 日（周五）<br>全天 | 注册台<br>Registration Desk |
| 16 | 全体大会 | 晚宴 & 专委会会员大会<br>Conference Dinner & General Assembly | 晚宴；中国发展战略学研究会先进材料与智能制造战略专业委员会会员大会 | 专委会秘书处 | 11 月 7 日（周六）<br>晚宴 19:00<br>会员大会 20:30–21:30 | 晚宴：豪生厅<br>大会：君和厅 |
| 17 | 配套活动 | Advanced 期刊校园行（清华大学材料学院站）<br>Advanced Journal Campus Tour · Tsinghua University | Wiley《Advanced Materials》系列期刊走进清华大学材料学院，与师生交流（编辑部报告、作者分享、圆桌讨论等）；ICMIA 2026 会期配套活动 | 组织方：Wiley · 清华大学材料学院 | 11 月 9 日（周一）<br>全天（具体时段待定） | 清华大学材料学院<br>School of Materials Science and Engineering, Tsinghua University |

# 大会总览 · Conference at a Glance

| 日期 Date | 上午 Morning | 下午 Afternoon | 晚上 Evening |
|---|---|---|---|
| 11 月 6 日<br>周五 Nov 6 (Fri) | 全天注册（注册台 全天） | 研究生论坛（分论坛七）13:00–18:25 · 君和厅（1F）<br>墙报交流 Poster Session I 16:30–18:00 · 墙报区 | — |
| 11 月 7 日<br>周六 Nov 7 (Sat) | 大会报告（一）08:30–12:05 · 豪生厅（1F）<br>含 Advanced Leaders Forum: AI-Powered Research and Innovation<br>第三届 Wiley Star Scientist Award 启动仪式 | 分论坛报告：分论坛一至六、专题论坛 S01 / S02、National Materials（13:00–18:40 不等）<br>墙报交流 Poster Session II 15:00–17:00 · 墙报区<br>Wiley 编辑面对面 15:00–17:00 · 嵩山厅 | 晚宴<br>专委会会员大会（中国发展战略学研究会先进材料与智能制造战略专业委员会） |
| 11 月 8 日<br>周日 Nov 8 (Sun) | 大会报告（二）08:30–12:00 · 豪生厅（1F）<br>含 Advanced City 启动仪式 | 分论坛报告：分论坛一至六、专题论坛 S01 / S02、SmartSys 编委会暨研讨会（13:30–18:40 不等）<br>墙报交流 Poster Session III 15:00–17:00 · 墙报区<br>Wiley 编辑面对面 15:00–17:00 · 嵩山厅 | — |
| 11 月 9 日<br>周一 Nov 9 (Mon) | Advanced 期刊校园行（清华大学材料学院站）<br>Advanced Journal Campus Tour · Tsinghua University<br>全天，具体时段待定 | （同左，全天活动） | — |

# 逐日日程 • Master Schedule by Day

| 日期 Date | 时间 Time | 活动 Event | 场地 Venue |
|---|---|---|---|
| 11 月 6 日 周五 Nov 6 (Fri) | 全天 All day | 注册报到 Registration | 注册台 Registration Desk |
| | 13:00–18:25 | 分论坛七 研究生论坛 Graduate Student Forum（30 场报告单日完成） | 君和厅（1F）Junhe Hall |
| | 16:30–18:00 | 墙报交流 Poster Session I（P-01–P-56） | 墙报区 Poster Area |
| 11 月 7 日 周六 Nov 7 (Sat) | 08:30–12:05 | 开幕式 & 大会报告（一）Opening Ceremony & Plenary Sessions | 豪生厅（1F）Haosheng Hall |
| | 13:00–18:30 | 分论坛三 Intelligent Sensing and New-Generation AI | 豪生厅 C（1F）Haosheng Hall C |
| | 13:30–17:15 | 分论坛二 Intelligent Manufacturing and Process Innovation | 兰月阁（2F）Lanyue Pavilion |
| | 13:30–18:30 | 分论坛一 Advanced Materials and AI Empowerment | 豪生厅 A（1F）Haosheng Hall A |
| | 13:30–17:00 | 分论坛五 05A/05B New Energy Materials and Green Manufacturing | 崂山厅 / 香山厅（1F） |
| | 13:30–18:35 | 分论坛四 Medical-Engineering Interdisciplinary Research | 君和厅（1F）Junhe Hall |
| | 13:30–18:40 | 专题论坛 S02 2D Materials | 枫叶厅（2F）Fengye Hall |
| | 13:50–17:35 | 专题论坛 S01 Superconducting Materials（13:50 学会领导致辞） | 葵月阁（2F）Kuiyue Pavilion |
| | 14:00–16:30 | 分论坛六 AI Empowering Science Communication and Academic Publishing | 樱月阁（2F）Yingyue Pavilion |
| | 14:00–17:30 | National Materials 专题论坛 Symposium | 泰山厅（1F）Taishan Hall |
| | 15:00–17:00 | 墙报交流 Poster Session II | 墙报区 Poster Area |
| | 15:00–17:00 | Wiley 编辑面对面 Wiley Meet the Editors | 嵩山厅 Songshan Hall |
| | 晚间 Evening | 晚宴 & 专委会会员大会 Dinner & General Assembly | 晚宴 19:00 · 豪生厅<br>会员大会 20:30–21:30 · 君和厅 |
| 11 月 8 日 周日 Nov 8 (Sun) | 08:30–12:00 | 大会报告（二）Plenary Sessions | 豪生厅（1F）Haosheng Hall |
| | 13:00–18:30 | 分论坛三 Intelligent Sensing and New-Generation AI | 豪生厅 C（1F）Haosheng Hall C |
| | 13:30–17:15 | 分论坛二 Intelligent Manufacturing and Process Innovation | 兰月阁（2F）Lanyue Pavilion |
| | 13:30–18:30 | 分论坛一 Advanced Materials and AI Empowerment | 豪生厅 A（1F）Haosheng Hall A |
| | 13:30–17:00 | 分论坛五 05A/05B New Energy Materials and Green Manufacturing | 崂山厅 / 香山厅（1F） |
| | 13:30–18:35 | 分论坛四 Medical-Engineering Interdisciplinary Research | 君和厅（1F）Junhe Hall |
| | 13:30–18:40 | 专题论坛 S02 2D Materials | 枫叶厅（2F）Fengye Hall |
| | 14:00–17:35 | 专题论坛 S01 Superconducting Materials | 葵月阁（2F）Kuiyue Pavilion |
| | 14:00–16:30 | 分论坛六 AI Empowering Science Communication and Academic Publishing | 樱月阁（2F）Yingyue Pavilion |
| | 15:00–17:00 | 墙报交流 Poster Session III | 墙报区 Poster Area |
| | 15:00–17:00 | Wiley 编辑面对面 Wiley Meet the Editors | 嵩山厅 Songshan Hall |
| | 15:30–17:00 | SmartSys 编委会暨研讨会 SmartSys Editorial Board and Symposium | 泰山厅（1F）Taishan Hall |
| 11 月 9 日 周一 Nov 9 (Mon) | 全天 All day | Advanced 期刊校园行（清华大学材料学院站）Advanced Journal Campus Tour · Tsinghua University | 清华大学材料学院 Tsinghua University |

# 大会报告

## PLENARY·SESSIONS

大会开幕式 · 大会报告 · 大会报告人简介

01

AI EMPOWERMENT · MATERIALS INNOVATION · INTELLIGENT MANUFACTURING

# Opening Ceremony & Plenary Sessions

大会开幕式及大会报告

| | |
|---|---|
| **Date：** | November 07 – 08, 2026 · Saturday – Sunday |
| **Time：** | 08:30 – 12:05 (UTC+8) · Day 1 / 08:30 – 12:00 · Day 2 |
| **Venue：** | 1F, Haosheng Hall (豪生厅) |

## — DAY 1 · NOVEMBER 07, 2026 (SATURDAY) · MORNING —

| Opening Ceremony & Plenary Sessions · Day 1 | | | |
|---|---|---|---|
| **Time** | **Session** | **Speaker / Panelists** | **Chair / Host** |
| 08:30 – 08:50 | **Opening Ceremony** | — | Jian Li (李健) |
| 08:50 – 09:20 | **Plenary Talk 1** | **Xiaogang Liu (刘小钢)** , National University of Singapore<br>*Title: Turning Scattering into Vision* | Esther Levy |
| 09:20 – 09:50 | **Plenary Talk 2** | **Klas Hjort** , Uppsala University<br>*Title: Robots – Implants – Sports Performance: Applications of Miniaturized Systems with Soft Materials* | Esther Levy |
| Coffee Break · 09:50 – 10:05 | | | |
| 10:05 – 10:20 | **3rd Wiley Star Scientist Award — Launch Ceremony** | — | Shirley Wang |
| 10:20 – 11:05 | **Panel Discussion Advanced Leaders Forum: AI-Powered Research and Innovation** | **Zhong Lin Wang** , Beijing Institute of Nanoenergy and Nanosystems, CAS<br>**Hai-Hu Wen (闻海虎)** , Nanjing University<br>**Francesca Santoro** , RWTH Aachen University & Forschungszentrum Jülich<br>**Ilia Valov** , Forschungszentrum Jülich GmbH<br>Allyn Molina , Wiley | Jing Li (李晶) |

| | | | |
|---|---|---|---|
| 11:05 – 11:35 | **Plenary Talk 3** | **Tim Coombs** , University of Cambridge<br>*Title: The AC loss conundrum* | Richard Murray |
| 11:35 – 12:05 | **Plenary Talk 4** | **Tae-Woo Lee** , Seoul National University<br>*Title: Pathways to Next-Generation Vivid and Intelligent Displays* | Richard Murray |

## — DAY 2 · NOVEMBER 08, 2026 (SUNDAY) · MORNING —

| Plenary Sessions · Day 2 | | | |
|---|---|---|---|
| **Time** | **Session** | **Speaker / Panelists** | **Chair / Host** |
| 08:30 – 09:00 | **Plenary Talk 5** | **Liming Dai (戴黎明)** , University of Science and Technology of China<br>*Title: Carbon-based Metal-free Electrocatalysts for Clean Energy-Chemical Conversion* | Joern Ritterbusch |
| 09:00 – 09:30 | **Plenary Talk 6** | **Jian S. Dai (戴建生)** , Southern University of Science and Technology<br>*Title: Invoking Structural Intelligence in Robotics* | Joern Ritterbusch |
| 09:30 – 10:00 | **Plenary Talk 7** | **Quanshui Zheng (郑泉水)** , Tsinghua University<br>*Title: Structural Superlubricity Technology: From Fundamental Science to Future Industrial Ecosystems* | Joern Ritterbusch |
| 10:00 – 10:15 | **Advanced City — Launch Ceremony** | Connecting Systems. Advancing Cities. | Jiaqi Li (李佳琪) |
| Coffee Break · 10:15 – 10:30 | | | |
| 10:30 – 11:00 | **Plenary Talk 8** | **Yuanzheng Yue (岳远征)** , Aalborg University<br>*Title: Our recent research progress on metal-organic framework glasses* | Till von Graberg |
| 11:00 – 11:30 | **Plenary Talk 9** | **Jinshan Pan (潘金山)** , KTH Royal Institute of Technology<br>*Title: Electrochemical-induced changes of surface passive films on advanced alloys revealed by synchrotron X-ray analyses* | Till von Graberg |
| 11:30 – 12:00 | **Plenary Talk 10** (online video) | **Konstantin Novoselov** , National University of Singapore<br>*Title: Materials for the Future* | Till von Graberg |



## Konstantin Novoselov

Nobel Laureate in Physics (2010); Tan Chin Tuan Centennial Professor, National University of Singapore; Langworthy Professor of Physics, University of Manchester, UK

### BIOGRAPHY

Konstantin Novoselov is a Russian-British physicist who was awarded the 2010 Nobel Prize in Physics for the discovery of graphene and his great contributions to materials science. He is an expert in condensed matter physics, mesoscopic physics and nanotechnology, and has published more than 700 papers. He is the Tan Chin Tuan Centennial Professor at the National University of Singapore, Director of the Institute for Functional Intelligent Materials (I-FIM) at NUS, and Langworthy Professor of Physics at the University of Manchester, UK. He is a Fellow of the Royal Society (FRS) and Chief Scientist of the Chongqing Institute for Nobel Laureates in 2D Materials, China. He was knighted in 2012 and elected a Foreign Member of the Chinese Academy of Sciences in 2023.

Professor Novoselov led the academic team involved in the design, construction and launch of the UK National Graphene Institute (NGI). As Distinguished Professor in the Department of Materials Science and Engineering at the National University of Singapore, he founded the Institute for Functional Intelligent Materials (I-FIM). His research focuses on functional intelligent materials, particularly two-dimensional materials (such as graphene) and their heterostructures, and he is committed to promoting the interdisciplinary integration of materials science and engineering, data science, and artificial intelligence.

### PLENARY TALK

## Materials for the Future

### ABSTRACT

*Abstract: To Be Confirmed.*




## Yuanzheng Yue

Professor of Chemistry, Aalborg University, Denmark


### BIOGRAPHY

Yuanzheng Yue is Professor of Chemistry at Aalborg University, Denmark. He obtained his Ph.D. degree from the Technical University of Berlin, Germany, in 1995. His research focuses on glasses and disordered materials. He has published more than 440 papers in peer-reviewed journals, including Nature and Science, and has delivered 140 invited talks, including 27 plenary/keynote lectures, at international conferences.

He is Fellow of the European Academy of Sciences, the Danish Academy of Natural Sciences, the Royal Society of Chemistry, the European Ceramics Society, and the Society of Glass Technology. He was awarded the Knight's Cross of the Order of the Dannebrog of Denmark in 2014, the Dalton Horizon Prize in 2025 for his pioneering work on metal-organic framework glasses, and the Nevill F. Mott Award in 2026 for his outstanding contributions to glass science.

### PLENARY TALK

## Our Recent Research Progress on Metal-Organic Framework Glasses

### ABSTRACT


Metal-organic frameworks (MOFs) are crystalline microporous 2D or 3D hybrid solids formed by metal ions or metal clusters connected by organic linkers through coordination bonds. In 2015, an international team including myself reported the first melt-quenched MOF glass (namely, ZIF-4 glass). Since then, MOF glasses have attracted widespread attention in the scientific community because they combine porosity, bulk-forming ability, and diverse functional properties — a combination of characteristics not found in MOF crystals or other categories of glass (such as metallic glasses, non-metallic inorganic glasses, and organic glasses).

In this talk, I will introduce the progress made by my research group in the study of MOF glasses and non-MOF hybrid glasses, such as metal-organic inorganic composite (MOIC) glasses. I will describe our new understanding of the glass formation mechanisms of both MOF and MOIC glasses, review our new insights into the structure-property-functionality relationships, and highlight the potential applications of these glasses, such as energy storage, light emission and gas separation. Finally, I will outline the key challenges and prospects facing research on MOF glasses and other hybrid glasses.




## Jinshan Pan

Professor of Surface and Corrosion Science, KTH Royal Institute of Technology, Sweden


### BIOGRAPHY

Jinshan Pan is Professor of Surface and Corrosion Science at KTH Royal Institute of Technology, Stockholm, Sweden, specializing in corrosion science. He earned his bachelor's and master's degrees in metal corrosion and protection from the University of Science and Technology Beijing, and received his Ph.D. in corrosion science from KTH in 1996. He previously worked at the Central Iron and Steel Research Institute, Beijing, and the Swedish Corrosion Institute, Stockholm, and was appointed full professor at KTH in 2010.

His research focuses on electrochemical and surface analyses of localized corrosion of advanced alloys and green protective coatings, combining synchrotron X-ray and neutron imaging techniques, NanoSIMS, DFT calculation and machine learning for multiscale studies of corrosion mechanisms. He has supervised 25 Ph.D. students and 10 postdocs and published 220 peer-reviewed papers, and has served as faculty opponent for doctoral disputations and reviewer for project proposals and academic positions in Sweden, Norway, Denmark, Belgium, the Netherlands, Austria, the UK and Australia.

### PLENARY TALK

## Electrochemical-Induced Changes of Surface Passive Films on Advanced Alloys Revealed by Synchrotron X-Ray Analyses

### ABSTRACT


Spontaneous formation of protective passive films on metal surfaces is crucial for the material's corrosion resistance in its service life, and the stability of the surface films under operation conditions determines the performance and lifetime of the devices made of the materials. Our understanding of the passive films has been significantly improved thanks to the development of advanced analytical techniques. Modern synchrotron X-ray sources offer unprecedented possibilities for detailed analyses and in situ and operando studies of the passive films in aqueous environments and under electrochemical polarization conditions.

This lecture presents our recent studies on passive films on advanced alloys by utilizing state-of-the-art synchrotron-based X-ray photoelectron spectroscopy (XPS) and other synchrotron techniques (X-ray diffraction/reflectivity/fluorescence), in combination with electrochemical analyses. The results reveal detailed structural and compositional changes in the passive films caused by electrochemical polarizations (applied potentials), and highlight the importance of the outermost hydroxide layers on the advanced industrial alloys.




## Klas Hjort

Professor of Materials Science, Uppsala University, Sweden


### BIOGRAPHY

Klas Hjort is Professor of Materials Science and Dean of Engineering at Uppsala University, Sweden. He is experienced in advanced microengineering; his earlier focus was on telecom applications using optical and radio-frequency MEMS. More recently, he has focused on heterogeneous microsystems on glass, ceramics, stainless steel, flexible foils and elastomers, for biomedicine and for wireless sensor and actuator nodes.

He has led national and European projects on wireless sensor and actuator networks based on his digital rigid-stretch printed circuit board technology. He coordinates the Horizon Europe project PERSIMMON, developing personalized and sustainable smart patches, and is developing miniaturized pneumatic control systems and cochlear implants in national projects.

### PLENARY TALK

## Robots – Implants – Sports Performance: Applications of Miniaturized Systems with Soft Materials

### ABSTRACT


Soft materials give comfort and can gently comply with a body. By introducing such materials into new application domains in the recent decade, this has created two technical revolutions: soft and stretchable microsystems for monitoring of biometrics in sports, healthcare, and in everyday life; and soft robotics, for applications in, e.g., logistics of soft and fragile materials, wearable robotics and humanoids.

More than a decade ago, we pioneered soft and stretchable printed circuit board technology with liquid metal circuitry and have since then been forwarding its use with increased maturity. In addition, we have recently started to use textile technology for robotic textiles. The developed technologies are demonstrated in microrobots for intelligent agriculture, a haptic garment, and soft electronics and pneumatics for cochlear implants, clinical monitoring and sport performance.

While intimate computing and physical AI provide means for advanced soft systems to perform well in and on our bodies, AI has put us in the middle of a paradigm shift in academic materials science. Teaching and research will utterly transform with the help and challenge of physical AI. Much of the theoretically and mathematically based materials science is evolving at a pace that makes planning for education nearly impossible. Still, data is king and experimental results are needed for validation of the rapidly evolving theoretical and simulation capabilities. For now, the productivity gain in AI-driven automated labs is immense in life sciences and materials synthesis, but we should expect similar productivity gains in all experimental fields when humanoids are further developed — and that should be very soon.

It is imperative to consider the implications of this for materials science in academia.




## Tae-Woo Lee

Professor of Materials Science and Engineering, Seoul National University, South Korea


### BIOGRAPHY

Tae-Woo Lee is Professor in the Department of Materials Science and Engineering at Seoul National University, Korea. He received his Ph.D. in Chemical Engineering from the Korea Advanced Institute of Science and Technology (KAIST) in 2002, joined Bell Laboratories, Lucent Technologies, USA, as a postdoctoral researcher, and worked at the Samsung Advanced Institute of Technology (2003–2008). He was an assistant and associate professor in the Department of Materials Science and Engineering at Pohang University of Science and Technology (POSTECH) before joining Seoul National University in 2016.

His research focuses on organic, metal halide perovskite, and carbon materials, and their applications to flexible electronics, printed electronics, displays, solid-state lighting, solar energy conversion devices, and bioinspired neuromorphic devices. He has published 311 papers in leading journals including Science, Nature, Nature Photonics, Nature Nanotechnology and Advanced Materials, and is the inventor or co-inventor of 445 patented technologies. He was honored as a 2020 MRS Fellow and a 2024 SPIE Fellow, and appointed a Fellow of the Korea Academy of Science and Technology in 2021. He has received numerous prestigious awards, including the Korea Young Scientist Award from the President of Korea (2008), the Korean Engineering Award (Presidential Award) (2021), and the Kyung-Ahm Prize (2023). He serves as an associate/executive editor of Organic Electronics and The Innovation Materials.

### PLENARY TALK

## Pathways to Next-Generation Vivid and Intelligent Displays

### ABSTRACT


Next-generation visual interfaces, wearable electronics, and bio-integrated systems require light-emitting technologies that simultaneously offer high luminescence efficiency, physical deformability, and active signal-processing functionality. However, conventional emissive platforms face intrinsic material and operational limitations: metal halide perovskites suffer from structural fragility and synthesis bottlenecks, while traditional organic optoelectronic architectures often lack mechanical elasticity or require high operational voltages that are incompatible with interactive and biological interfaces. Here, we present a multidisciplinary framework addressing these challenges across metal halide perovskite emitters, intrinsically stretchable organic light-emitting diodes (OLEDs), and low-voltage electrochemical organic light-emitting transistors (OLETs).

For perovskite emitters, practical implementation has long been hindered by soft ionic lattices susceptible to ion migration and environmental degradation, rapid crystallization kinetics that cause defect proliferation during batch scale-up, and phase segregation in dry deposition processes. To overcome operational instability, we established an interbonded PbSO4-SiO2-polymer hierarchical shell that mechanically locks the ionic crystal framework. This interfacial pinning restricts lattice expansion and passivates reactive surface sites, yielding an external photoluminescence quantum yield of 91.4% and operational longevity surpassing 20,000 hours under blue-light excitation. To resolve synthesis scaling limits where localized thermal and concentration gradients typically trigger defective burst crystallization, we developed a sub-4 °C pseudo-emulsion cold-injection method that moderates haloplumbate coordination kinetics. This suppresses defect formation and facilitates uniform 20-liter mass synthesis, realizing electroluminescent devices with a 29.6% external quantum efficiency. Furthermore, addressing the phase-mixing problem of vapor-deposited perovskites, a thermodynamically guided vacuum co-deposition strategy using functional X-type spacers and in-situ formed LiF nanoscale hetero-scaffolds selectively promotes phase-pure quasi-two-dimensional nanostructures, achieving thermally evaporated light-emitting diodes with a 21.9% efficiency and a narrow linewidth of 78.5 meV.

Beyond rigid formats, expanding optoelectronics toward deformable and intelligent interfaces requires combining mechanical elasticity with low-voltage signal processing. Addressing the severe exciton quenching and charge-injection barriers in elastomeric matrices, we realize fully stretchable OLEDs by integrating an exciplex-assisted phosphorescent layer with MXene-contact stretchable electrodes. The resulting devices achieve a record-high EQE of 17.0% and sustain robust emission with negligible luminance degradation under 60% tensile strain. Concurrently, to eliminate the high driving voltages and unstable recombination zones of conventional organic transistors, we demonstrate single-active-layer electrochemical OLETs operating below 3.5 V. By incorporating an ion transport enhancer to induce drain-side electric double layers, these devices overcome electron injection barriers to establish a 267 μm wide pinned recombination zone, enabling battery-powered synaptic visual platforms for neuromorphic feedback. Collectively, these coordinated material and device innovations establish a versatile foundation for robust, deformable, and intelligent optoelectronic systems.



## Tim Coombs

Professor of Electrical Engineering, University of Cambridge, UK

### BIOGRAPHY

Timothy Coombs is Professor of Electrical Engineering at the University of Cambridge, where he leads the EPEC Superconductivity Group and is a Fellow of Magdalene College. He is also a visiting professor at Tsinghua University, Sichuan University and Shenyang University of Technology. He received all of his degrees from the University of Cambridge.

His research focuses on high-temperature superconductivity (HTS), superconducting motors, flux pumps, superconducting magnets and finite-element modelling of superconductors (H-formulation), with applications ranging from fusion energy and MRI medical magnets to superconducting fault current limiters. His group has achieved a number of world-first results. He has published over 210 papers, holds several patents, and has long been engaged in superconductivity research collaboration in China.

### PLENARY TALK

## The AC Loss Conundrum

### ABSTRACT

The dream of a world with clean and infinite energy has driven human beings to devote effort to the R&D of nuclear fusion for decades. Now, thanks to the rapid development of high-temperature superconducting (HTS) wires, we have never been closer to commercial fusion power reactors and ultimate clean energy. Producers all over the world are now supplying over 10,000 km of superconducting wires to commercial companies to build fusion reactors. Even though the current performance of HTS wires is roughly sufficient for compact fusion magnets, and the manufacturing technology is still fast-progressing, there are scientific and technical obstacles to overcome. The AC loss is the most crucial one, and it holds back the development of HTS fusion reactors and a host of other applications such as data centres, motors, generators, etc.

To mitigate the AC loss we are concentrating on creating multilayer structures using a combination of selective oxygenation and insulating layers, in order to create a possible solution as provided by PSALM (Patterned Superconductor for AC Loss Minimisation), a novel structure of HTS coated conductors which aims to replicate a roebel-type structure in a single tape without the need for cutting or assembly, and which will drastically reduce the AC loss.



## Quanshui Zheng

Academician of the Chinese Academy of Sciences; Professor, Tsinghua Shenzhen International Graduate School, Tsinghua University; Founding President, Shenzhen X-Institute, China

### BIOGRAPHY

Quanshui Zheng is Academician of the Chinese Academy of Sciences, Professor at Tsinghua Shenzhen International Graduate School, Tsinghua University, and Founding President of the Shenzhen X-Institute. He established a comprehensive theoretical framework for tensor functions in constitutive equations and pioneered structural superlubricity science and technology — achievements that earned him the Second Prize of China's National Natural Science Award in 2004 and 2017, respectively, as lead recipient.

In education, he created a new model for cultivating outstanding innovative talent across engineering disciplines, recognized with the First Prize of the National Higher Education Teaching Achievement Award (2018), the Baosteel Outstanding Teacher Grand Prize (2019), and the Third Outstanding Educator Award (2021). His current research interests include structural superlubricity science and technology, artificial intelligence and interdisciplinary research, and innovation-motivated education (iME) and mechanics.

### PLENARY TALK

## Structural Superlubricity Technology: From Fundamental Science to Future Industrial Ecosystems

### ABSTRACT

As artificial intelligence moves from the digital realm into the physical world, how can miniature devices achieve long-lasting, energy-efficient, and reliable motion? Friction and wear remain fundamental challenges that must be overcome.

Structural superlubricity harnesses the unique structures and interactions at solid interfaces to enable ultralow-friction, wear-free sliding without lubricants. It opens new avenues for designing micro- and nanoelectromechanical systems and for integrating mechanical motion with electrical and thermal transport.

Drawing on more than two decades of research by Academician Quanshui Zheng and his team, this talk will introduce the physical mechanisms, key scientific breakthroughs, and engineering advances in structural superlubricity. It will explore potential applications in miniature motors, radio-frequency switches, energy harvesting, and emerging data storage technologies. The talk will also examine how pioneering technologies can bridge the gap between laboratory research and industrial application, and how fundamental research, talent development, and technology transfer can advance together to build industrial ecosystems for the future.




## Liming Dai

Professor, Suzhou Institute for Advanced Research, University of Science and Technology of China, China


### BIOGRAPHY

Liming Dai is Professor at the Suzhou Institute for Advanced Research, University of Science and Technology of China (USTC). He is an elected member/fellow of the Australian Academy of Science, the Australian Academy of Technological Sciences and Engineering, the European Academy of Sciences, the US National Academy of Inventors, the American Institute for Medical and Biological Engineering, and the European Academy of Natural Sciences, and an ARC Australian Laureate Fellow. He received his B.Sc. in polymer chemical engineering from Zhejiang University in 1983 and his Ph.D. in chemistry from the Australian National University in 1991, followed by postdoctoral research at the Cavendish Laboratory, University of Cambridge.

His research focuses on functional polymers and carbon nanomaterials, in particular carbon nanotubes, metal-free carbon catalysts and materials for energy conversion. He has published more than 600 papers in Science, Nature-family journals and other leading publications, with over 140,000 citations and an h-index of 186. He serves as Associate Editor of Nano Energy and has been repeatedly recognized as a globally Highly Cited Researcher.

### PLENARY TALK

## Carbon-Based Metal-Free Electrocatalysts for Clean Energy-Chemical Conversion

### ABSTRACT


Since our discovery of the first carbon-based metal-free electrocatalyst (C-MFEC, i.e., N-doped carbon nanotubes) for oxygen reduction in fuel cells in 2009, the field of C-MFECs has grown enormously. C-MFECs, as alternatives to noble metal-based electrocatalysts, have been widely demonstrated for efficient oxygen reduction, oxygen evolution, hydrogen evolution, carbon dioxide reduction, nitrogen reduction, and many other electrocatalytic reactions. Recent worldwide research effort has shown great potential for applications of C-MFECs in fuel cells for clean energy conversion, metal-air batteries for energy storage, water splitting for hydrogen fuel generation, and other electrochemical processes for clean production of value-added chemicals. Further research and development of C-MFECs could transform clean energy and green chemistry technologies.

In this talk, I will summarize some of our work on the development of C-MFECs for clean energy-chemical conversion, along with an overview of recent advances, current challenges, and future perspectives in this exciting field.



## Jian S. Dai

Fellow of the Royal Academy of Engineering; Dean of the Institute of Robotics Research, SUSTech–KCL Joint School; Chair Professor, King's College London, UK

### BIOGRAPHY

Jian S. Dai is a Fellow of the Royal Academy of Engineering, a Member of Academia Europaea (The Academy of Europe), and a Fellow of the Royal Society of Arts and Manufactures, as well as Fellow of IEEE and ASME. He is Chair Professor at King's College London and Dean of the Institute of Robotics Research at the SUSTech–KCL Joint School. He is a pioneering figure in metamorphic and reconfigurable mechanisms and robotics, origami robots, and geometric kinematics, and founded the triennial international conference series on Reconfigurable Mechanisms and Robots (ReMAR).

He serves as Editor-in-Chief of Robotica and subject editor of Mechanism and Machine Theory, and has received the ASME DED Mechanisms and Robotics Award, the ASME Machine Design Award, and the IFToMM Award of Merit. He has published over 400 journal papers and 8 authored books, and has guided more than 100 Ph.D. students and postdoctoral researchers. His 17-chapter monograph Screw Algebra and Geometric Kinematics has just been published by Springer in the Springer Tracts in Advanced Robotics series.

### PLENARY TALK

## Metamorphosis: Invoking Structural Intelligence in Robotics

### ABSTRACT

Advanced embodied AI demands a seamless integration between artificial intelligence and physical embodiment. Marking the culmination of foundational advances captured in the 17-chapter monograph Screw Algebra and Geometric Kinematics, this talk explores how robotic systems undergo disruptive structural transformations to unlock true structural and physical intelligence. Grounded in the biological principles of cellular growth and adaptation, metamorphic mechanisms enable variable topology, variable degrees of freedom (DoF), and variable structures, proposing a new design paradigm. By fusing evolutionary morphology with multimodal adaptation strategies, these dynamic systems achieve multi-level topological reconfiguration and material-structure-function co-evolution. This synergy seamlessly unites perception, actuation, control, and self-healing into an autonomous framework, significantly enhancing robotic adaptability and operational efficiency in complex environments.




## Xiaogang Liu

Distinguished Professor, Department of Chemistry, National University of Singapore, Singapore


### BIOGRAPHY

Xiaogang Liu is a Distinguished Professor at the National University of Singapore (NUS). He obtained his Ph.D. from Northwestern University, USA, in 2004, and subsequently carried out postdoctoral research in the Department of Materials Science and Engineering at MIT. He joined the faculty at NUS in 2006 and was promoted to Full Professor in 2017.

His research spans several areas of materials chemistry and nanoscience, with particular emphasis on energy transfer processes in lanthanide-doped nanomaterials, optical nanomaterials for neuromodulation and light-field imaging, advanced scintillators for X-ray imaging, and the design of electronic tools for assistive technologies.

### PLENARY TALK

## Turning Scattering into Vision

### ABSTRACT


Scattering is usually viewed as a fundamental limitation in imaging, blurring information and reducing resolution. In this talk, I will present our recent efforts to transform scattering from noise into a source of hidden information for next-generation sensing and imaging. I will first introduce a high-dimensional light-field sensing platform that uses disordered photonics and machine learning to simultaneously decode multiple properties of light, including spectrum, polarization, directionality, and angular momentum from a single shot measurement. I will then discuss our recent work on X-ray imaging, where depth-dependent scattering inside scintillators is treated as an invertible information transport process. By combining physics-informed models with AI-driven reconstruction, we recover high-resolution information from strongly scattered X-ray signals without changing detector hardware. Together, these studies highlight a new paradigm in which scattering becomes a computational resource for vision, imaging, and information extraction.

# 分论坛

## PARALLEL·SYMPOSIA

分论坛一 至 分论坛七 · 七大并行分会场

02

AI EMPOWERMENT · MATERIALS INNOVATION · INTELLIGENT MANUFACTURING

# Parallel Symposium 01

# Advanced Materials and AI Empowerment

分论坛一：先进材料与人工智能赋能 · 会议程序

| | |
|---|---|
| **Date:** | November 07 – 08, 2026 · Saturday – Sunday |
| **Time:** | 13:30 – 18:30 (UTC+8) · Daily |
| **Venue:** | 1F, Haosheng Hall （豪生厅 A ） |

## Symposium Chairs · 分论坛主席



**Longfei Wang 王龙飞**
Beijing Institute of Nanoenergy and Nanosystems, CAS



**Ke Liu 刘珂**
Peking University



**Fei Wu 吴飞**
Chongqing University



**Libo Chen 陈立博**
Uppsala University, Sweden



**Lixi Wang 王丽熙**
Nanjing Tech University, China



**Esther Levy**
Advanced Materials Editor-in-Chief · Wiley

## — DAY 1 · NOVEMBER 07, 2026 (SATURDAY) —

### Symposium 01: Advanced Materials and AI Empowerment

| Time | No. | Report Title & Speaker |
|---|---|---|
| **Session Chairs: Prof. Libo Chen (Uppsala University) · Prof. Iek Man LEI (University of Macau)** | | |
| 13:30 – 13:55 | 01 | Conjugated Oligoelectrolytes: A Versatile Platform for Membrane Modifications (Keynote)<br>**Guillermo C. Bazan, Nanyang Technological University, Singapore** |
| 13:55 – 14:20 | 02 | Nature's Blueprint: Engineering the Next Generation of Bioinspired Hybrid Materials (Keynote)<br>**Mato Knez, CIC nanoGUNE, Spain** |
| 14:20 – 14:45 | 03 | Physics-Informed AI for Material Characterization and Inverse Design (Keynote)<br>**Seunghwa Ryu, Korea Advanced Institute of Science and Technology, Korea** |
| 14:45 – 15:10 | 04 | Towards Single Crystals of Covalent Organic Polymers and Frameworks (Keynote)<br>**Qichun Zhang, City University of Hong Kong, Hong Kong, China** |
| 15:10 – 15:25 | 05 | Ferroelectric Polarization Engineering in Epitaxial ScAlN (Invited)<br>**Ping Wang, Peking University, China** |
| **Coffee Break 15:30 – 15:45** | | |
| **Session Chairs: Prof. Fei Wu (Chongqing University) · Prof. Ping Wang (Peking University)** | | |
| 15:45 – 16:10 | 06 | Title: To Be Announced (Keynote)<br>**Wenjun Zhang, City University of Hong Kong, Hong Kong, China** |
| 16:10 – 16:35 | 07 | Liquid Crystals, Photoalignment and Battery Technology (Keynote)<br>**Kristiaan Neyts, The Hong Kong University of Science and Technology, Hong Kong, China** |
| 16:35 – 17:00 | 08 | Hybrid Multifunctional Materials for Emerging Energy Technologies: From Photovoltaics to Neuromorphics (Keynote)<br>**Jovana Milic, University of Turku, Finland** |

| | | |
|---|---|---|
| 17:00 – 17:15 | 09 | Designing Bioinspired Materials via 3D Printing and Ice-Templating (Invited)<br>**Iek Man LEI, University of Macau, Macau, China** |
| 17:15 – 17:30 | 10 | Autonomous Laboratory for New Materials Development Based on Few-Shot Self-Evolving Agents (Invited)<br>**Shitong Wang, Beihang University, China** |
| 17:30 – 17:45 | 11 | Low-Concentration Nonanal Gas-Sensing Materials for Agricultural Product Storage Monitoring (Invited)<br>**Chao Zhang, Yangzhou University, China** |
| 17:45 – 17:55 | 12 | Texture-Based Interlayer Boundary Detection in SEM Images of Multilayer Paintings (Oral)<br>**Anna Mikhailova, Federal Research Center of Chemical Physics, Russian Academy of Sciences, Russia** |
| **Dinner 18:30** | | |

## DAY 2 · NOVEMBER 08, 2026 (SUNDAY)

### Symposium 01: Advanced Materials and AI Empowerment

| Time | No. | Report Title & Speaker |
|---|---|---|
| **Session Chairs: Prof. Longfei Wang (Beijing Institute of Nanoenergy and Nanosystems, CAS) · Prof. Hengyu Guo (Chongqing University)** | | |
| 13:30 – 13:45 | 13 | Self-Powered and Self-Healing Dielectric Elastomer Actuators Based Artificial Muscle with Triboelectric Nanogenerators (Invited)<br>**Dan Yang, Beijing University of Chemical Technology, China** |
| 13:45 – 14:00 | 14 | 力学超材料结构与振动控制 (Invited)<br>**Xin Fang, National University of Defense Technology, China** |
| 14:00 – 14:15 | 15 | Biosensing on Soft Tissues (Invited)<br>**Ting Wang, Nanjing University of Posts and Telecommunications, China** |
| 14:15 – 14:30 | 16 | Wireless Self-Powered Sensor Systems and Their Applications in Healthcare Monitoring (Invited)<br>**Yannan Xie, Nanjing University of Posts and Telecommunications, China** |

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|---|---|---|
| 14:30 – 14:45 | **17** | Piezo-phototronic Effects in GaN based Laser Diodes by Extreme Pressure Application with Nanometer Resolution (Invited)<br>**Ding Li, Beijing Institute of Nanoenergy and Nanosystems, CAS, China** |
| 14:45 – 15:00 | **18** | Neuromorphic Tactile Sensory Systems for Biomedical Engineering (Invited)<br>**Libo Chen, Uppsala University, Sweden** |
| 15:00 – 15:15 | **19** | High-Performance Triboelectric Nanogenerators for Intelligent Sports (Invited)<br>**Jianjun Luo, Beijing Institute of Nanoenergy and Nanosystems, CAS, China** |
| **Coffee Break 15:30 – 15:45**<br><br>**Session Chairs: Prof. Ting Wang (Nanjing University of Posts and Telecommunications) · Prof. Xin Fang (National University of Defense Technology)** | | |
| 15:45 – 16:00 | **20** | Performance Enhancement Strategies and Application Exploration of Novel Triboelectric Energy Conversion Technology (Invited)<br>**Hengyu Guo, Chongqing University, China** |
| 16:00 – 16:15 | **21** | Single-Atom/Nanocluster-Mediated Thermo-, Electro-, and Contact-Electrocatalysis for Green Valorization of Industrial Flue Gas toward Value-Added Chemicals (Invited)<br>**Jun Wu, Central South University, China** |
| 16:15 – 16:30 | **22** | Surface/Interface Charge Regulation and Energy Harvesting Devices (Invited)<br>**Zhihao Zhao, Beijing Institute of Nanoenergy and Nanosystems, CAS, China** |
| 16:30 – 16:45 | **23** | High-Performance Alloys Designed via Large Language Models and Knowledge Graphs (Invited)<br>**Honghui Wu, University of Science and Technology Beijing, China** |
| 16:45 – 17:00 | **24** | Defect Engineering for Multifunctional Electromagnetic Wave Absorption (Invited)<br>**Song Ma, Institute of Metal Research, CAS, China** |
| 17:00 – 17:10 | **25** | High-Efficiency Contact-Electro-Catalysis (CEC) Enabled by Electrostatic Polarization (Oral)<br>**Ziming Wang, University of New South Wales, Australia** |

| | | |
|---|---|---|
| 17:10 – 17:20 | 26 | Design of a Biomimetic Intelligent Muscle System (Oral)<br>**Wenhui Chen, Peking University, China** |
| 17:20 – 17:30 | 27 | Phase Stability of Multicomponent Rare-Earth-Doped Zirconia Ceramics (Oral)<br>**Tong Zhang, Beijing University of Technology, China** |
| **17:30 – 17:40** | **28** | **When Liquid Crystals encounters Structured Light (Oral) Le Zhou, Tsinghua University, China** |
| **Dinner** | | |

# Parallel Symposium 02

# Intelligent Manufacturing and Process Innovation

分论坛二：智能制造与工艺创新 · 会议程序

| | |
|---|---|
| **Date:** | November 07 – 08, 2026 · Saturday – Sunday |
| **Time:** | 13:30 – 17:20 (UTC+8) · Daily |
| **Venue:** | 2F, Lanyue Pavilion (兰月阁) |

## Forum Chairs · 分论坛主席



**Wenbo Ding 丁文伯**

Tsinghua Shenzhen International Graduate School, Tsinghua University



**Renyun Zhang 张仁云**

Mid Sweden University; Beijing Institute of Nanoenergy and Nanosystems, CAS



**Xinjun Liu 刘辛军**

Tsinghua University



**Yuhong Liu 刘宇宏**

Tsinghua University



**Zhe Chen 陈哲**

Zhejiang University



**Rusen Yang 杨如森**

Xidian University



**Xiaoqiang Lu 陆孝强**

Nanyang Technological University, Singapore



**Richard Murray**

Wiley · Publishing Editor, Advanced journals (Advanced Intelligence, Advanced Science, Advanced Discovery, Advanced Materials)

## — DAY 1 · NOVEMBER 07, 2026 (SATURDAY) —

### Symposium 02: Intelligent Manufacturing and Process Innovation

| Time | No. | Report Title & Speaker |
|---|---|---|
| **Session Chairs: Liaoyuan Wang 王燎原 (Tsinghua University) • 13:30 – 14:35 (UTC+8)** | | |
| 13:30 – 13:50 | 01 | A Digital Twin-Driven Ultra-precision Freeform Machining System (Keynote)<br>**Xichun Luo 罗熙淳, University of Strathclyde, UK** |
| 13:50 – 14:10 | 02 | Beyond Bulk Properties: Transient Surface Engineering for Augmented Ultraprecision Machining (Keynote)<br>**Hao Wang 王浩, National University of Singapore, Singapore** |
| 14:10 – 14:25 | 03 | Superhard Materials for High-Speed FSW of Cast Aluminum Alloys and FSW of High-Strength Steels (Invited)<br>**Nina Qin 秦景霞, Element Six UK Ltd, UK** |
| 14:25 – 14:35 | 04 | AI-Driven Friction Prediction and Inverse Design of Two-Dimensional Materials for Intelligent Manufacturing (Oral)<br>**Shiyi Song 宋时羿, Tsinghua University, China** |
| **Session Chairs: Wenbo Ding 丁文伯 (Tsinghua Shenzhen International Graduate School, Tsinghua University) • 14:35 – 15:35 (UTC+8)** | | |
| 14:35 – 14:50 | 05 | An Active-Learning Framework for Machine-Learning Potential Development in Mechanochemical Coupling Systems: A Case Study of Co CMP (Invited)<br>**Yating Huang 黄雅婷, Beijing Technology and Business University, China** |
| 14:50 – 15:05 | 06 | Key Technologies of Augmented Reality-Assisted Assembly Guidance and Inspection (Invited)<br>**Jianfu Zhang 张建富, Tsinghua University, China** |
| 15:05 – 15:20 | 07 | 具身智能机器人助力农业现代化 (Invited)<br>**Zihua Zhang 张子华, Beijing University of Technology, China** |
| 15:20 – 15:35 | 08 | 基于动态三维场景表征的机器人导航与操作 (Invited)<br>**Shufei Li 李树飞, Tianjin University, China** |
| **Tea Break 15:35 – 15:45** | | |

| Session Chairs: Renyun Zhang 张仁云 (Mid Sweden University; Beijing Institute of Nanoenergy and Nanosystems, CAS) • 15:45 – 17:10 (UTC+8) | | |
|---|---|---|
| 15:45 – 16:05 | 09 | Wood Nanofiber Assembly for Sustainable Water Management (Keynote)<br>**Wenshuai Chen 陈文帅, Northeast Forestry University, China** |
| 16:05 – 16:25 | 10 | AI-Driven Digitization of Dynamic Hand Motion into Soft Matter (Keynote)<br>**Jinhye Bae, Chung-Ang University, Republic of Korea; UC San Diego, USA** |
| 16:25 – 16:40 | 11 | Origami-Inspired Triboelectric Nanogenerators for Simultaneous Energy and Information Harvesting (Invited)<br>**Guobiao Hu 胡国标, The Hong Kong University of Science and Technology (Guangzhou), China** |
| 16:40 – 16:55 | 12 | 尾流诱导振动型摩擦纳米发电机用于低流速水流能量采集与自供能感知 (Invited)<br>**Junlei Wang 王军雷, Zhengzhou University, China** |
| 16:55 – 17:10 | 13 | Integrated Optimization of Full-Process Processing Parameters Based on Artificial Intelligence (Invited)<br>**Wenjing Wang 王文静, University of Science and Technology Beijing, China** |

## — DAY 2 · NOVEMBER 08, 2026 (SUNDAY) —

### Symposium 02: Intelligent Manufacturing and Process Innovation

| Time | No. | Report Title & Speaker |
|---|---|---|
| **Session Chairs: Xiaoqiang Lu 陆孝强 (Nanyang Technological University, Singapore) • 13:30 – 14:35 (UTC+8)** | | |
| 13:30 – 13:50 | 01 | 生成式 AI 赋能自主化学实验：具身智能化学机器人关键技术 (Keynote)<br>**Zhengcai Cao 曹政才, Harbin Institute of Technology, China** |
| 13:50 – 14:10 | 02 | 多品种变批量产品智能制造数字孪生车间关键技术及应用 (Keynote)<br>**Ying Cheng 程颖, Beihang University, China** |
| 14:10 – | 03 | Flexure-based Dynamic Vibration Absorbers: Design Theory and |

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|---|---|---|
| 14:25 | | Applications in Machining Chatter Control (Invited)<br>**Wenshuo Ma 马文硕, Beihang University, China** |
| 14:25 – 14:35 | **04** | Improvement of Creep Resistance in Ni-based Superalloys via Compact γ′/γ″ Co-precipitation Design (Oral)<br>**Shengyu Zhou 周生玉, Tianjin University, China** |
| **Session Chairs: Zhe Chen 陈哲 (Zhejiang University) • 14:35 – 15:45 (UTC+8)** | | |
| 14:35 – 14:55 | **05** | 硬脆材料复杂曲面器件超精密加工技术 (Keynote)<br>**Wule Zhu 朱昊乐, Zhejiang University, China** |
| 14:55 – 15:10 | **06** | Exploring Tellurium-Based Semiconductor Nanostructures for Emerging Electronics (Invited)<br>**Johnny Ho 何颂贤, City University of Hong Kong, Hong Kong, China** |
| 15:10 – 15:30 | **07** | 高端装备制造业离散车间梯度化智能制造系统构建模式与实施路线——以轨道交通装备行业为例 (Keynote)<br>**Zengqiang Jiang 蒋增强, Beijing Jiaotong University, China** |
| 15:30 – 15:45 | **08** | Cellulose Materials for Triboelectric Energy Harvesting: from Fundamental to Engineering (Invited)<br>**Renyun Zhang 张仁云, Mid Sweden University, Sweden** |
| **Tea Break 15:45 – 15:55** | | |
| **Session Chairs: Rusen Yang 杨如森 (Xidian University) • 15:55 – 17:20 (UTC+8)** | | |
| 15:55 – 16:15 | **09** | 3D Printing of Conformal Electronic Systems (Keynote)<br>**Jin Huang 黄进, Xidian University, China** |
| 16:15 – 16:35 | **10** | 各向异性二维材料的可控制备和光电器件 (Keynote)<br>**Hua Xu 徐华, Shaanxi Normal University, China** |
| 16:35 – 16:55 | **11** | Design and Construction of Flexible Optoelectronic Devices for Healthcare Monitoring and Therapy (Keynote)<br>**Peng Li 李鹏, Northwestern Polytechnical University, China** |
| 16:55 – 17:10 | **12** | New Materials for 2D, 3D and 4D Printing (Invited)<br>**Shlomo Magdassi, The Hebrew University of Jerusalem, Israel** |
| 17:10 – 17:20 | **13** | Temperature Field Analysis and Thermal Effects on the Dynamic Characteristics of Constant-Flow Closed Hydrostatic Turntables (Oral) |

Jianqiao Bao 鲍建桥, Beijing University of Technology, China

# Parallel Symposium 03

# Intelligent Sensing and New-Generation AI

分论坛三：智能传感与新一代人工智能 · 会议程序

| | |
|---|---|
| **Date：** | November 07 – 08, 2026 · Saturday – Sunday |
| **Time：** | 13:00 – 18:30 (UTC+8) · Daily |
| **Venue：** | 1F, Haosheng Hall (豪生厅 C) |

## Symposium Chairs · 分论坛主席



**Junyi Zhai 翟俊宜**
Beijing Institute of Nanoenergy and Nanosystems, CAS



**Zhen Wen 文震**
Institute of Functional Nano & Soft Materials, Soochow University



**Gulnur Kalimuldina**
Nazarbayev University, Kazakhstan



**Tinghai Cheng 程廷海**
Beijing Institute of Nanoenergy and Nanosystems, CAS



**Joern Ritterbusch**
Editor-in-Chief, Advanced Functional Materials, Wiley

## — DAY 1 · NOVEMBER 07, 2026 (SATURDAY) —

### Symposium 03: Intelligent Sensing and New-Generation AI

| Time | No. | Report Title & Speaker |
|---|---|---|
| | | **Session Chairs: Rusen Yang (Xidian University)** |
| 13:30 – 13:50 | 01 | Harnessing Mechanical Energy for Light Emission (Keynote)<br>**Feng Wang, City University of Hong Kong, Hong Kong, China** |
| 13:50 – 14:10 | 02 | Extending the cycle life Li anode (Keynote)<br>**Quan Li, The Chinese University of Hong Kong, Hong Kong, China** |
| 14:10 – 14:30 | 03 | Materials Design and Control of Functionalities of Electrochemical Artificial Neurons and Synapses (Keynote)<br>**Ilia Valov, Peter Grünberg Institute, Germany** |
| 14:30 – 14:50 | 04 | Title: To Be Confirmed (Keynote)<br>**Ni Zhao, The Chinese University of Hong Kong, Hong Kong, China** |
| 14:50 – 15:10 | 05 | Device-Level AI with Intelligent Sensing and Neuromorphic Hardware (Keynote)<br>**Hocheon Yoo, Hanyang University, Korea** |
| 15:10 – 15:25 | 06 | Smart Healthcare Carpet for Parkinson's Disease Gait Monitoring in Natural Scenarios (Invited)<br>**Hao Wu, South China University of Technology, China** |
| | | **Coffee Break • 茶歇 15:30 – 15:45** |
| | | **Session Chairs: Hao Wu (South China University of Technology) · Fei Liang (Northwestern Polytechnical University)** |
| 15:45 – 16:05 | 07 | A New Silk Road towards Smart Wearables (Keynote)<br>**Yingying Zhang, Tsinghua University, China** |
| 16:05 – 16:20 | 08 | Advances in Metabolite Self-assemblies and Their Energy Harvesting Application (Invited)<br>**Rusen Yang, Xidian University, China** |
| 16:20 – 16:35 | 09 | From Lead-Free Ceramics to Fully Organic Systems: Electromechanical Coupling in Hybrid Nanogenerators for Self-Powered Sensing (Invited)<br>**Naratip Vittayakorn, King Mongkut's Institute of Technology** |

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| | | **Ladkrabang, Thailand** |
| 16:35 – 16:50 | **10** | Charge to Spin Conversion: Materials and Devices (Invited)<br>**Xiaoguang Xu, University of Science and Technology Beijing, China** |
| 16:50 – 17:05 | **11** | Flexible/Wearable Sensors and Systems (Invited)<br>**Fang Yi, Sun Yat-sen University, China** |
| 17:05 – 17:20 | **12** | Chemistry at Contact Electrification Interfaces: Catalytic Reactions and Biomedical Opportunities (Invited)<br>**Peng Jiang, Wuhan University, China** |
| 17:20 – 17:35 | **13** | Wireless and Self-powered Sensing of Water-droplet Motion and its Application to Aircraft Safety Warning (Invited)<br>**Fei Liang, Northwestern Polytechnical University, China** |
| 17:35 – 17:45 | **14** | Micro-nano Structure Modulation by Capillarity Manipulation at the Liquid-Solid-Gas Three-phase Boundaries and Its Applications in Smart Mechano-responsive Materials (Oral)<br>**Yang Liu, Sun Yat-sen University, China** |
| 17:45 – 17:55 | **15** | Self-powered Luminescent System (Oral)<br>**Junlu Sun, Zhengzhou University, China** |
| 17:55 – 18:05 | **16** | RF Oscillator-based Battery-free Self-powered Instantaneous Wireless Sensing System (Oral)<br>**Jinkai Chen, Hangzhou Dianzi University, China** |
| 18:05 – 18:15 | **17** | Twist Contact-Based Skew-Gaussian Transistor and Integrated Classification Hardware System (Oral)<br>**Youngmin Han, Hanyang University, Korea** |
| 18:15 – 18:30 | **18** | Mechano-iontronic Effects for Smart Sensing Applications (Invited)<br>**Xiong Pu, Beijing Institute of Nanoenergy and Nanosystems, CAS, China** |

**Dinner • 晚宴 19:00 • 豪生厅 (Haosheng Hall)**

## DAY 2 · NOVEMBER 08, 2026 (SUNDAY)

### Symposium 03: Intelligent Sensing and New-Generation AI

| Time | No. | Report Title & Speaker |
|---|---|---|
| **Session Chairs: Haiwu Zheng (Henan University) · Fumin Shang (Changchun Institute of Technology)** | | |
| 13:30 – 13:50 | **01** | Bioinspired Nanoconfined Iontronics (Keynote)<br>**Di Wei, Beijing Institute of Nanoenergy and Nanosystems, CAS, China** |
| 13:50 – 14:10 | **02** | Micro- and Nanostructure Engineering of Metallic Glasses for Intelligent Sensing Applications (Keynote)<br>**Si Lan, Nanjing University of Science and Technology, China** |
| 14:10 – 14:25 | **03** | Olfaction Platform based on MEMS Gas Sensor Array (Invited)<br>**Xuhui Sun, Soochow University, China** |
| 14:25 – 14:40 | **04** | Mechano-Electric Fiber Materials and Self-Powered Devices (Invited)<br>**Kai Dong, Beijing Institute of Nanoenergy and Nanosystems, CAS, China** |
| 14:40 – 14:55 | **05** | AI-Enabled Intelligent Sensing of Human Physiological Signals via Wearable Flexible Sensor Arrays (Invited)<br>**Haiwu Zheng, Henan University, China** |
| 14:55 – 15:10 | **06** | In-situ Energy Harvesting and Self-powered Sensing for Intelligent Operation and Maintenance of Marine and Offshore Equipment (Invited)<br>**Taili Du, Dalian Maritime University, China** |
| 15:10 – 15:25 | **07** | Multimodal Sensing Platforms for Intelligent Health Monitoring (Invited)<br>**Lin Xu, Jilin University, China** |
| **Coffee Break • 茶歇 15:30 – 15:45** | | |
| **Session Chairs: Lin Xu (Jilin University) · Xiao Zhang (Changchun Institute of Technology)** | | |
| 15:45 – 16:00 | **08** | Carbon Nanotube-based High-performance Bioelectronics (Invited)<br>**Youfan Hu, Peking University, China** |
| 16:00 – 16:15 | **09** | Artificial Intelligence-empowered Signal Processing and Sensing Technologies (Invited)<br>**Azamat Yeshmukhametov, Nazarbayev University, Kazakhstan** |
| 16:15 – 16:30 | **10** | Contact-Electro-Dynamic Therapy (CEDT): A New Strategy for Reactive Oxygen Species-Mediated Therapy (Oral) Haimei Li, South-Central Minzu University, China |

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| 16:30 – 16:40 | **11** | Interface Engineering for High-performance Near-room-temperature Thermoelectric Films (Oral)<br>**Qingxue Hu, Nanjing University of Science and Technology, China** |
| 16:40 – 16:50 | **12** | The Application of TENG in Intelligent Transport Systems (Oral)<br>**Yikang Li, Changchun University of Technology, China** |
| 16:50 – 17:00 | **13** | A Wearable Bimodal Sensing System with Physics-Guided Early Decoding for Low-Latency Motor Intent Inference (Oral)<br>**Jiarui Zhao, University of Chinese Academy of Sciences, China** |
| 17:00 – 17:10 | **14** | A Stretchable Droplet Electricity Generator Enabled by Gradient-Charged Interfaces (Oral)<br>**Lei Lv, Northwestern Polytechnical University, China** |
| 17:10 – 17:20 | **15** | Topological Proprioception at the Wrist for Human-Machine Interaction (Oral)<br>**Meihua Zhou, University of Chinese Academy of Sciences, China** |
| 17:20 – 17:30 | **16** | Atomically Confined Insertion for 2D Strain and Polarization Engineered GaN Electronics (Oral)<br>**Yuanhong Shi, University of Chinese Academy of Sciences, China** |
| **Dinner** | | |

# Parallel Symposium 04

# Medical-Engineering Interdisciplinary Research and Intelligent Materials & Devices

分论坛四：医工交叉与智能材料器件 · 会议程序

| | |
|---|---|
| **Date：** | November 07 – 08, 2026 · Saturday – Sunday |
| **Time：** | 13:30 – 18:35 (UTC+8) · Daily |
| **Venue：** | 1F, Junhe Hall (君和厅) |

## Symposium Chairs · 分论坛主席



**Yanglong Hou 侯仰龙**
Sun Yat-sen University



**Sang-Woo Kim**
Yonsei University, South Korea



**Dan Luo 罗聃**
Beijing Institute of Nanoenergy and Nanosystems, CAS



**Jing Yu 余靓**
Zhejiang University of Technology



**Yan Liu 刘燕**
Peking University School of Stomatology



**Partha Pratim Pal**
Deputy Editor, Chemistry – An Asian Journal, Wiley



**Tao Yang 杨涛**
Editor, Advanced Science; Advanced Materials Editor, Wiley



**Xi Wen 温茜**
Editor-in-Chief, Small Methods; Deputy Editor, Small, Wiley

## — DAY 1 · NOVEMBER 07, 2026 (SATURDAY) —

### Symposium 04: Medical-Engineering Interdisciplinary Research and Intelligent Materials & Devices

| Time | No. | Report Title & Speaker |
|---|---|---|
| | | **Session Chairs: Prof. Lorenzo Moroni, Prof. Yan Liu** |
| 13:30 – 13:50 | 01 | Title: Research basis and translational application exploration of Nanobiological adaptation (Keynote)<br>**Xingjie Liang, National Center for Nanoscience and Technology, CAS, China** |
| 13:50 – 14:10 | 02 | Title: Intelligent Nanorobots for One Health (Keynote)<br>**Martin Pumera, Brno University of Technology, Czech Republic** |
| 14:10 – 14:30 | 03 | Title: To Be Confirmed (Keynote)<br>**Francesca Santoro, RWTH Aachen University, Germany** |
| 14:30 – 14:50 | 04 | Title: Probing Function with Designing Structure: Instructive Scaffolds for Intelligently Manufactured Tissue Regeneration (Keynote)<br>**Lorenzo Moroni, Maastricht University, Netherlands** |
| 14:50 – 15:10 | 05 | Title: Intelligent biomimetic scaffold driven by bacterial energy promotes the repair of infectious bone defects (Keynote)<br>**Yan Liu, Peking University, China** |
| 15:10 – 15:30 | 06 | Title: Artificial Intelligence-Guided Nano Co-Assembly for Next-Generation Drug Delivery (Keynote)<br>**Helder Santos, University Medical Center Groningen, Netherlands** |
| 15:30 – 15:50 | 07 | Title: Engineering Adaptive Bioelectronics for Living Systems (Keynote)<br>**Changsheng Wu, National University of Singapore, Singapore** |
| | | **Coffee Break · 茶歇 15:50 – 16:00** |
| | | **Session Chairs: Prof. Xingjie Liang, Prof. Tingting Li, Prof. Xiaodong Zhang, Prof. Jianxun Ding, Prof. Ping'an Ma** |

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| 16:00 – 16:20 | 08 | Title: Reversing Abnormal Phase Separation for Disease Treatment (Keynote)<br>**Tingting Li, Peking University, China** |
| 16:20 – 16:40 | 09 | Title: Cluster-based Enzymes and the Repair of Neural Injury (Keynote)<br>**Xiaodong Zhang, Tianjin University, Tianjin, China** |
| 16:40 – 17:00 | 10 | Title: Bioactive Poly(amino acid) Materials (Keynote)<br>**Jianxun Ding, Institute of Applied Chemistry, CAS, Changchun, China** |
| 17:00 – 17:20 | 11 | Title: Biomaterials for Reactive Oxygen Species Homeostasis Regulation (Keynote)<br>**Ping'an Ma, Harbin Engineering University, China** |
| 17:20 – 17:35 | 12 | Title: Biomimetic assembly of lanthanide nanomaterials and their hemostatic application research (Invited)<br>**Jing Yu, Zhejiang University of Technology, China** |
| 17:35 – 17:50 | 13 | Title: Inorganic Functional Nanomaterials for Tumor Immunotherapy (Invited)<br>**Chunxia Li, Shandong University, China** |
| 17:50 – 18:05 | 14 | Title: Full-API Nanodrugs (FANDs) and Their Biomedical Applications (Invited)<br>**Jinfeng Zhang, Beijing Institute of Technology, China** |
| 18:05 – 18:20 | 15 | Title: Interface catalysis induced by contact electrification effect and its application (Invited)<br>**Peng Jiang, Wuhan University, China** |
| 18:20 – 18:32 | 16 | Title: Multidimensional reshaping of tumor microenvironment mediated by immune regulatory probes (Invited)<br>**Shuren Wang, Sun Yat-sen University, China** |

**Dinner · 晚餐**

## DAY 2 · NOVEMBER 08, 2026 (SUNDAY)

### Symposium 04: Medical-Engineering Interdisciplinary Research and Intelligent Materials & Devices

| Time | No. | Report Title & Speaker |
|---|---|---|
| | | **Session Chairs: Prof. Ping Yu, Prof. Guosheng Song** |
| 13:30 – 13:50 | **17** | Title: Electroactive Biomaterials and Tissue Repair (Keynote)<br>**Zhou Li, Tsinghua University, China** |
| 13:50 – 14:10 | **18** | Title: Discovery of enzyme activity (Keynote)<br>**Huiyu Liu, Beijing University of Chemical Technology, China** |
| 14:10 – 14:25 | **19** | Title: Functional DNA Nanomaterials and Immune Engineering (Invited)<br>**Yu Yang, Shanghai Jiao Tong University School of Medicine, China** |
| 14:25 – 14:40 | **20** | Title: Design of Machine-Learning-Assisted Photo-Enzyme Integrated Catalysts (Invited)<br>**Xin Yu, University of Jinan, China** |
| 14:40 – 14:55 | **21** | Title: Hydrogel wearable electronic devices for human electrocardiogram monitoring (Invited)<br>**Lin Qiu, University of Science and Technology Beijing, China** |
| 14:55 – 15:10 | **22** | Title: Aqueous Supramolecular Polymerization of Biodegradable Nanoparticles via Pre-assembly Guided Disulfide Exchange Reaction (Invited)<br>**Bingran Yu, Beijing University of Chemical Technology, China** |
| | | **Coffee Break · 茶歇 15:10 – 15:20** |
| | | **Session Chairs: Prof. Zhou Li, Prof. Huiyu Liu** |
| 15:10 – 15:30 | **23** | Title: Ionic transport behavior and application of polyelectrolyte confinement (Keynote)<br>**Ping Yu, Institute of Chemistry, CAS, Beijing, China** |
| 15:30 – 15:45 | **24** | Title: Sub-femtonewton force sensing and super-resolved temperature measuring (Invited)<br>**Fan Wang, Beihang University, China** |
| 15:45 – 16:00 | **25** | Title: Immunological activation of albumin@porous silicon nanocomposites on innate immunity for cancer immunotherapy (Invited)<br>**Bing Xia, Nanjing Forestry University, China** |

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| 16:00 – 16:15 | **26** | Title: Chiral Assemblies for the Disaggregation of Amyloid Fibrils in Neurodegenerative Diseases (Invited)<br>**Ke Hou, Harbin Institute of Technology (Shenzhen), China** |
| 16:15 – 16:30 | **27** | Title: Antibacterial Biomaterials Based on Cuproptosis-Like Mechanisms (Invited)<br>**Xianwen Wang, Anhui Medical University, China** |
| 16:30 – 16:42 | **28** | Title: Design and Applications of Electroactive Biomaterials (Invited)<br>**Jiajun Qiu, Shanghai Institute of Ceramics, Chinese Academy of Sciences** |
| 16:42 – 16:54 | **29** | Title: Ti Interface Design and Functional Modulation of Metallic Implants for Infection Control and Osseointegration (Invited)<br>**Wenhao Zhou, Northwest Institute for Nonferrous Metal Research, China** |
| 16:54 – 17:06 | **30** | Title: Caries Prevention and Treatment Materials (Invited)<br>**Chunmei Ding, Sichuan University, China** |
| 17:06 – 17:18 | **31** | Title: Single-atom Catalyst Initiates Acute Lung Injury Immunotherapy by Inhibiting Macrophage Pyroptosis (Invited)<br>**Xiangyu Lu, Tongji University, China** |
| 17:18 – 17:30 | **32** | Title: Developing Low-Cost Biosensors and Point-of-Care Diagnostic Platforms: Translating Laboratory Innovation Toward Real-World Market (Invited)<br>**Lichen, Xiang, Henan University, China** |
| 17:30 – 17:42 | **33** | Title: Nanoenzymes as a new generation of antibacterial agents: from construction to application in anti-infective therapy (Invited)<br>**Xiaojun He, Peking University First Hospital, China** |
| 17:42 – 17:54 | **34** | Title: Osteoporosis Treatment via Programmed Delivery of IRF5 siRNA to Macrophages in Bone Tissue Combined with ROS Scavenging (Invited)<br>**Yuting Niu, Peking University, China** |
| 17:54 – 18:06 | **35** | Title: Design and Health Monitoring Application of Polyvinylidene Fluoride Flexible Piezoelectric Sensing System (Invited)<br>**Yuanzheng Zhang, Henan University, China** |

## DAY 2 · NOVEMBER 08, 2026 (SUNDAY)

| Symposium 04: Medical-Engineering Interdisciplinary Research and Intelligent Materials & Devices--Graduate Student Forum | | |
|---|---|---|
| **Time** | **No.** | **Report Title & Speaker**<br>**Session Chairs: Prof. Dan Luo** |
| 18:10 – 18:15 | 1 | Title: A wireless closed-Loop vagus nerve stimulation platform for rapid antidepressant neuromodulation (Oral)<br>**Jian Chen, Fudan University, China** |
| 18:15 – 18:20 | 2 | Title: Natural Small-Molecule Drug-Driven Supramolecular Materials: Construction Strategies and Biological Applications (Oral)<br>**Xiaohang Guo, Xiangya Hospital, Central South University, China** |
| 18:20 – 18:25 | 3 | Title: Hydrothermally Engineered Herbal Nanoparticles Repair the Neurovascular Unit after Traumatic Brain Injury (Oral)<br>**Menghan Cheng, Xiangya Hospital, Central South University, China** |
| 18:25 – 18:30 | 4 | Title: A Rhubarb Anthraquinone-Based Self-Assembled Hydrogel for Attenuating Neuroinflammation Following Traumatic Brain Injury (Oral)<br>**Haonan Zhu, Xiangya Hospital, Central South University, China** |
| 18:30 – 18:35 | 5 | Title: Tumor Chemosensitization via Mitochondrial Metabolic Reactivation (Oral)<br>**Shuyue Deng, China Pharmaceutical University, China** |
| 18:35 – 18:40 | 6 | Title: All-magneto-dielectric metasurface with Ultrathin and Ultra-broadband Electromagnetic Absorption (Oral)<br>**Jie Zhang, Zhejiang University of Technology, China** |
| 18:40 – 18:45 | 7 | Title: Shake-to-Clear Intelligent Optical Switching in Weakly Assembled Nanorod Bundles (Oral)<br>**Tuo Su, Zhejiang University of Technology, China** |
| 18:45 – 18:50 | 8 | Title: Targeted Intervention of Tumor Metabolic Vulnerabilities Using Metal-Based Nanomaterials (Oral)<br>**Ran Ma, Peking University, China** |
| **Dinner · 晚餐** | | |

# Parallel Symposia 05A & 05B

# New Energy Materials and Green Manufacturing

分论坛五：新能源材料与绿色制造（c-Science 平行论坛）· 会议程序

| | |
|---|---|
| **Date：** | November 07 – 08, 2026 · Saturday – Sunday |
| **Time：** | 13:30 – 17:00 (UTC+8) · Daily |
| **Venue：** | 1F, 05A - Laoshan Hall (崂山厅)<br>1F, 05B - Xiangshan Hall (香山厅) |

## Symposium Chairs · 分论坛主席



**Shuhui Sun 孙书会**
INRS (National Institute of Scientific Research), Canada



**Shaojun Guo 郭少军**
Peking University



**Xinmei Hou 侯新梅**
University of Science and Technology Beijing



**Jianmin Ma 马建民**
Tiangong University



**Shuhong Jiao 焦淑红**
University of Science and Technology of China



**Hua Wang 王华**
Beihang University



**Chao Lai 赖超**
Jiangsu Normal University



**Zhenhui Ma 马振辉**
Beijing Technology and Business University



**Till von Graberg**
Editor-in-Chief, Advanced Energy Materials, Wiley

# — DAY 1 · NOVEMBER 07, 2026 (SATURDAY) —

## Symposium 05A: New Energy Materials and Green Manufacturing · Part 1

| Time | No. | Report Title & Speaker |
|---|---|---|
| **Session Chairs: Yijing Wang (王一菁), Nankai University · Jianmin Ma (马建民), Tiangong University** | | |
| 13:30 – 13:50 | 01 | Title: Electrode – Electrolyte Design and Operando Insights for Safe, Durable, and High-Energy Batteries (Keynote)<br>**Shuhui Sun (孙书会), Institut National de la Recherche Scientifique (INRS), Canada** |
| 13:50 – 14:10 | 02 | Making Robust Aqueous Zinc Batteries (Keynote)<br>**Hongjin Fan (范红金), Nanyang Technological University, Singapore** |
| 14:10 – 14:30 | 03 | 2D Metal Oxide Nanostructures for Sustainable Energy Technologies (Keynote)<br>**Ziqi Sun, Queensland University of Technology, Australia** |
| 14:30 – 14:50 | 04 | Reversible Solid Oxide Cell for Integrated Energy Storage and Power Generation (Keynote)<br>**Zhipeng Li (李致朋), Northwestern Polytechnical University, China** |
| 14:50 – 15:10 | 05 | Design of Fiber Separators for High-Performance Aqueous Zinc-Ion Batteries (Keynote)<br>**Guanjie He (何冠杰), University College London, UK** |

**Coffee Break • 茶歇　15:10 – 15:20**

## Symposium 05A: New Energy Materials and Green Manufacturing · Part 2

| Time | No. | Report Title & Speaker |
|---|---|---|
| **Session Chairs: Yijing Wang (王一菁), Nankai University · Jianmin Ma (马建民), Tiangong University** | | |
| 15:20 – 15:40 | 06 | Aqueous Aluminum-ion Batteries (Keynote)<br>**Qingyu Yan (颜清宇), Nanyang Technological University, Singapore** |

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|---|---|---|
| 15:40 – 16:00 | 07 | Advanced Thermoelectric Cooling Materials (Keynote)<br>**Lidong Zhao (赵立东), Beihang University, China** |
| 16:00 – 16:15 | 08 | Ni/Co Based Catalysis for Sulfur Cathodes in Wide-temperature-range Sodium–Sulfur Batteries (Invited)<br>**Wei Zhou (周苇), Beihang University, China** |
| 16:15 – 16:30 | 09 | Composite Solid Electrolytes for Solid-state Li Metal Batteries (Invited)<br>**Jie Zhao (赵婕), Fudan University, China** |
| 16:30 – 16:45 | 10 | Research on Electrode/Electrolyte Design and Ion Interfacial Transport Mechanisms for High-Safety Energy Storage Batteries (Invited)<br>**Huajun Tian (田华军), North China Electric Power University, China** |
| 16:45 – 16:55 | 11 | Low-Temperature Sodium Storage in O3-Type Layered Oxide Cathodes Enabled by Nb Doping-Induced Structural Stabilization and $Na^+$ Kinetics Optimization (Oral)<br>**Xinnan Zhang (张歆楠), Taiyuan University of Technology, China** |
| **16:55 – 17:05** | **12** | **Structural Regulation of Coal Tar Pitch-based Hard Carbon for Sodium Storage (Oral)Wenjing Zhou (周文静), Taiyuan University of Technology, China** |
| **Discussion / Closing • 讨论与总结　17:05 – 17:10 (5 min)** | | |

## Symposium 05B: New Energy Materials and Green Manufacturing · Part 1

| Time | No. | Report Title & Speaker |
|---|---|---|
| **Session Chairs: Jun Chen(陈俊), University of Wollongong · Junfei Liang(梁君飞), North University of China** | | |
| 13:30 – 13:50 | 01 | Unlocking the Synergy of External Fields for Enhanced Electrocatalysis and Photoreforming (Keynote)<br>**Zhiqun Lin (林志群), National University of Singapore, Singapore** |
| 13:50 – 14:10 | 02 | Diamond Materials for Electrochemical Energy Applications (Keynote)<br>**Nianjun Yang (杨年俊), Hasselt University, Belgium** |
| 14:10 – 14:30 | 03 | Defective Carbon-based Materials for Electrocatalysis (Keynote)<br>**Jun Chen (陈俊), University of Wollongong, Australia** |

| | | |
|---|---|---|
| 14:30 – 14:50 | 04 | Reimagining Energy Harvesting Materials – Green Synthesis and Manufacturing from Thermoelectric to Piezoelectric Materials & Devices (Keynote)<br>**Peter C. Sherrell, RMIT University, Australia** |
| 14:50 – 15:05 | 05 | Customization of Mesoporous Energy Materials (Invited)<br>**Zaiwang Zhao (赵再望), Inner Mongolia University, China** |
| 15:05 – 15:20 | 06 | Precise Design of Local Structures in Catalysts for Water Electrolysis (Invited)<br>**Yao Zhou (周遥), Beijing Institute of Technology, China** |

**Coffee Break • 茶歇 15:20 – 15:30**

## Symposium 05B: New Energy Materials and Green Manufacturing · Part 2

| Time | No. | Report Title & Speaker |
|---|---|---|

**Session Chairs: Jun Chen（陈俊）, University of Wollongong • Junfei Liang（梁君飞）, North University of China**

| | | |
|---|---|---|
| 15:30 – 15:45 | 07 | High-mass-loading Electrode Materials for Sodium-ion Batteries (Invited)<br>**Junfei Liang (梁君飞), North University of China, China** |
| 15:45 – 16:00 | 08 | Regulating Hydrogen-Bonding Chemistry for High-Performance Aqueous Ammonium-Ion Batteries (Invited)<br>**Pu Hu (胡朴), Wuhan Institute of Technology, China** |
| 16:00 – 16:15 | 09 | Spin-Enhanced Electrocatalysis and Dynamic Electrochemical Interfaces (Invited)<br>**Jing Wang (王静), Yanshan University, China** |
| 16:15 – 16:30 | 10 | Local Coordination Engineering for Ultrahigh-Capacity Zinc Storage in Vanadium-Based Cathodes (Invited)<br>**Yan Zhao (赵岩), Inner Mongolia University, China** |
| 16:30 – 16:45 | 11 | Direct Synthesis of Hydrogen Peroxide (Invited)<br>**Zengxi Wei (危增曦), Guangxi University, China** |

**Discussion / Closing • 讨论与总结 16:45 – 17:00 (15 min)**

# — DAY 2 · NOVEMBER 08, 2026 (SUNDAY) —

## Symposium 05A: New Energy Materials and Green Manufacturing · Part 1

| Time | No. | Report Title & Speaker |
|---|---|---|
| **Session Chairs: Hua Wang（王华）, Beihang University • Zhenhui Ma（马振辉）, Beijing Technology and Business University** | | |
| 13:30 – 13:50 | 01 | Low Carbon Processes for Efficient Manufacturing of Battery Materials (Keynote)<br>**Deepak Dubal, Queensland University of Technology, Australia** |
| 13:50 – 14:10 | 02 | Physics-Aware Digital Twins & Human-in-the-Loop Battery Manufacturing (Keynote)<br>**Alejandro A. Franco, Université de Picardie Jules Verne, France** |
| 14:10 – 14:30 | 03 | Intelligent Ore Sorting Technology and Its Application in Lithium Mines (Keynote)<br>**Xianping Luo (罗仙平), Jiangxi University of Water Resources and Electric Power, China** |
| 14:30 – 14:50 | 04 | Defective Layered Double Hydroxide Based Nanostructured Photocatalysts for $N_2$ Fixation (Keynote)<br>**Tierui Zhang (张铁锐), Technical Institute of Physics and Chemistry, CAS, China** |
| **Coffee Break • 茶歇　14:50 – 15:00** | | |
| 15:00 – 15:20 | 05 | Barocaloric Effect: from Phase Transition to Dissolution (Keynote)<br>**Bing Li (李昺), Institute of Metal Research, CAS, China** |

## Symposium 05A: New Energy Materials and Green Manufacturing · Part 2

| Time | No. | Report Title & Speaker |
|---|---|---|
| **Session Chairs: Hua Wang（王华）, Beihang University • Zhenhui Ma（马振辉）, Beijing Technology and Business University** | | |
| 15:20 – 15:35 | 06 | Design and Fabrication of Energy Materials via Spin Regulation (Invited)<br>**Han Hu (胡涵), China University of Petroleum (East China), China** |

| | | |
|---|---|---|
| 15:35 – 15:50 | 07 | The Magnetoelectric Regulation Concept of Ultra-thin Broadband Electromagnetic Wave Absorbing Materials (Invited)<br>**Zhenhui Ma (马振辉), Beijing Technology and Business University, China** |
| 15:50 – 16:05 | 08 | Interfacial Electron Transfer Model (Invited)<br>**Long Kong (孔龙), Northwestern Polytechnical University, China** |
| 16:05 – 16:20 | 09 | Cyclable Micron-sized Elemental Electrode Materials-based Low-temperature Alkali Metal Batteries (Invited)<br>**Dandan Yu (于丹丹), China Jiliang University, China** |
| 16:20 – 16:35 | 10 | Preparation of Key Electrode Materials for Novel Potassium-Based Energy Storage (Invited)<br>**Shuoqing Zhao (赵硕卿), Jilin University, China** |
| 16:35 – 16:45 | 11 | Material and Interface Design for High-Energy-Density All-Solid-State Lithium Metal Batteries (Oral)<br>**Yijie Liu (刘一杰), Nanjing University, China** |

**Discussion / Closing • 讨论与总结　16:45 – 17:00 (15 min)**

## Symposium 05B: New Energy Materials and Green Manufacturing · Part 1

| Time | No. | Report Title & Speaker |
|---|---|---|

**Session Chairs: Xinmei Hou（侯新梅）, University of Science and Technology Beijing • Chao Lai（赖超）, Jiangsu Normal University**

| | | |
|---|---|---|
| 13:30 – 13:50 | 01 | Towards Single Crystals of Covalent Organic Polymers/Frameworks (Keynote)<br>**Qichun Zhang (张其春), City University of Hong Kong, China** |
| 13:50 – 14:10 | 02 | The Role of Interfaces in High-performance and Sustainable Organic Solar Cells and Photodetectors (Keynote)<br>**Nicola Gasparini, Imperial College London, UK** |
| 14:10 – 14:30 | 03 | Light-Matter-Spin Interaction in Multiscale Chiral Nanostructures for Energy Conversion, Light Emission and Precision Nanomedicine (Keynote)<br>**Dong Ha Kim, Ewha Womans University, South Korea** |

**Coffee Break • 茶歇　14:30 – 14:40**

| | | |
|---|---|---|
| 14:40 – 14:55 | 04 | Aerogel-Based Materials for Efficient Energy Conversion (Invited)<br>**Jing Yang (杨静), Hunan Normal University, China** |
| 14:55 – 15:10 | 05 | Current-Assisted Catalytic Removal of Air Pollutants and Its Enhancement Mechanisms (Invited)<br>**Yibo Zhang (张一波), Ganjiang Innovation Academy, CAS, China** |

## Symposium 05B: New Energy Materials and Green Manufacturing · Part 2

| Time | No. | Report Title & Speaker |
|---|---|---|
| **Session Chairs: Xinmei Hou(侯新梅), University of Science and Technology Beijing · Chao Lai(赖超), Jiangsu Normal University** | | |
| 15:10 – 15:25 | 06 | Where Biology Meets Materials: Artificial and Semi-Artificial Photosynthesis for Sustainable Fuels and Circular Chemistry (Invited)<br>**Sai Kishore Ravi, City University of Hong Kong, China** |
| 15:25 – 15:40 | 07 | Key Materials for High-Energy-Density and Fast-Charging Rechargeable Batteries (Invited)<br>**Guoxing Li (李国兴), Shandong University, China** |
| 15:40 – 15:55 | 08 | Catalyst Design and Mechanistic Regulation for Waste Carbon Valorization (Invited)<br>**Shuai Yue (岳帅), Taiyuan University of Technology, China** |
| 15:55 – 16:10 | 09 | Two-Dimensional Nanofluidic Membranes for Osmotic Energy Harvesting (Invited)<br>**Qianqian Zhang (张倩倩), Beijing University of Technology, China** |
| 16:10 – 16:25 | 10 | In Situ Interfacial Studies of Spectrum-Electro-Chemo-Mechanical Coupled Systems for Rechargeable Batteries (Invited)<br>**Weifeng Huang (黄伟峰), Inner Mongolia University, China** |
| 16:25 – 16:40 | 11 | Electrode-Electrolyte Interface Engineering towards Efficient Energy Storage (Keynote)<br>**Wenjun Zhang (张文军), City University of Hong Kong, China** |
| **Discussion / Closing • 讨论与总结　16:40 – 17:00 (20 min)** | | |

# Parallel Symposium 06

# AI Empowering Science Communication and Academic Publishing

分论坛六：AI 赋能科学传播与学术出版 · 会议程序

| | |
|---|---|
| **Date:** | November 07 – 08, 2026 · Saturday – Sunday |
| **Time:** | 14:00 – 17:00 (UTC+8) · Daily |
| **Venue:** | 2F, Yingyue Pavilion (樱月阁) |

## Symposium Chairs · 分论坛主席



**Jian Li 李健**

Editorial Director, Physical Sciences APAC, Wiley



**Jiuhong Qian 钱九红**

Vice President, China Periodicals Association; Editor-in-Chief, Youke Publishing (Beijing) Co., Ltd.

## — DAY 1 · NOVEMBER 07, 2026 (SATURDAY) —

| Symposium 06: AI Empowering Science Communication and Academic Publishing | | |
|---|---|---|
| **Time** | **No.** | **Report Title & Speaker** |
| | | **Session Chair: Wen Ma (Youke Publishing)** |
| 14:00 – 14:30 | **01** | An Attempt and Exploration on the Integration and Transformation of Funded Research Achievements from the National Natural Science Foundation (Invited)<br>《国家自然科学基金资助成果贯通与转化的尝试与探索》<br>**Dong Li, National Natural Science Foundation of China** |
| 14:30 – 15:00 | **02** | The Application and Usage Boundaries of AI in the Management of Research Integrity (Invited)<br>《AI 在科研诚信管理中的应用与使用边界》<br>**Silvia Luo, Wiley** |
| | | **Coffee Break 茶歇 · 15:00 – 15:30** |
| 15:30 – 16:00 | **03** | Digital Publishing and AI Application at Youke Publishing (Invited)<br>**Hailiang Li, Youke Publishing** |
| 16:00 – 16:30 | **04** | AI Assisted Submission Screening in Wiley Physical Sciences Journals (Invited)<br>《Wiley 旗下物质科学期刊的 AI 辅助审稿策略与审稿机制》<br>**Alick Zu, Wiley** |
| 16:30 – 17:00 | **05** | Exploring Aggregate Science: An Introduction to Aggregate (Invited)<br>**Qiyao Li, Aggregate** |
| | | **Dinner** |

## — DAY 2 · NOVEMBER 08, 2026 (SUNDAY) —

| Symposium 06: AI Empowering Science Communication and Academic Publishing | | |
|---|---|---|
| **Time** | **No.** | **Report Title & Speaker** |
| | | **Session Chair: Jian Li (Wiley)** |
| 14:00 – 14:30 | **01** | From Content to Capabilities: Unlocking the Value of Scholarly Knowledge in the AI Era (Invited)<br>**Jing Li, Wiley** |
| 14:30 – 15:00 | **02** | Wiley 助力高质量期刊发展 (Invited)<br>**Thomas Wang, Wiley** |
| | | **Coffee Break　茶歇　·　15:00 – 15:30** |
| 15:30 – 16:00 | **03** | Challenges and Governance of AI's Deep Involvement in Academic Publishing (Invited)<br>《AI 深度介入学术出版的挑战与治理》<br>**Hong Xiao, Tongfang Knowledge Network Digital Technology Co., Ltd.** |
| 16:00 – 16:30 | **04** | New Cornerstone Science Foundation: Stable Support for Discovery Research in China (Invited)<br>**Yong Wang, New Cornerstone Science Foundation** |

# Parallel Symposium 07

# Graduate Student Forum

分论坛七：研究生论坛 · 会议程序

| | |
|---|---|
| **Date:** | November 06, 2026 · Friday |
| **Time:** | 13:00 – 18:25 (UTC+8) |
| **Venue:** | 1F, Junhe Hall (君和厅) |

## Forum Chairs • 论坛主席



**Weipeng Wang 王炜鹏**

Tsinghua University



**Ruqiang Zou 邹如强**

Peking University



**Chunnian He 何春年**

Tianjin University



**Lidong Zhao 赵立东**

Beihang University



**Xingwang Cheng 程兴旺**

Beijing Institute of Technology



**Qingliang Liao 廖庆亮**

University of Science and Technology Beijing



**Xiaoli Xi 席晓丽**

Beijing University of Technology



**Haobin Zhang 张好斌**

Beijing University of Chemical Technology



**Guocheng Lv 吕国诚**

China University of Geosciences (Beijing)

支持单位：清华大学材料学院 · 北京大学材料学院 · 北京航空航天大学材料学院 · 北京理工大学材料学院 · 北京科技大学材料学院 · 北京化工大学材料学院 · 北京工业大学材料学院 · 中国地质大学（北京）材料学院 · 天津大学材料学院

AI EMPOWERMENT · MATERIALS INNOVATION · INTELLIGENT MANUFACTURING

## — NOVEMBER 06, 2026 (FRIDAY) —

| Symposium 07: Graduate Student Forum | | |
|---|---|---|
| **Time** | **No.** | **Report Title & Speaker** |
| 13:00 – 13:15 | 01 | Title: 面向国家重大战略需求 促进基础研究创新成果交流——Fundamental Research 期刊建设与介绍<br>**刘灿, 国家自然科学基金委员会科学传播与成果转化中心（科学基金杂志社）出版部主任** |
| 13:15 – 13:30 | 02 | Manuscript Selection: Perspectives from SCIE Senior Editors<br>**马雯, 有科期刊出版（北京）有限公司副总经理** |
| 13:30 – 13:45 | 03 | Publishing in Wiley Materials Science Journals<br>**翁博, 《Macromolecular Rapid Communications》期刊主编 · 《Advanced Materials》期刊副主编** |
| 13:45 – 13:55 | 04 | Multiscale Interfacial Engineering for High-Performance Magnesium Batteries<br>**许康杰, 南京工业大学** |
| 13:55 – 14:05 | 05 | Machine Learning-Assisted Low-Temperature Thermal-Force Coupling Carbonization of Customized Hard Carbon Microstructures Enables High-Performance Sodium-Ion Batteries<br>**孙宗富, 天津大学** |
| 14:05 – 14:15 | 06 | Triple-Anchoring Binder for Improved Cyclability of Dry-Processed NCM811 Cathodes in Lithium-Ion Batteries<br>**吕梦歌, 北京理工大学** |
| 14:15 – 14:25 | 07 | Synthesis and Structural Design of Lithium Manganese Iron Phosphate (LFMP) Cathode Materials for High-Performance Lithium-Ion Batteries<br>**韦政宇, 广西大学** |
| 14:25 – 14:35 | 08 | Surface Modification of $Li_3InCl_6$ Provides Superior Electrochemical Performance for Lithium-Rich Manganese-Based Cathode Materials<br>**许光迪, 广西大学** |
| 14:35 – 14:45 | 09 | Disentangling Polymer Chains for Fast $Na^+$ Transport at Low Temperatures<br>**黄成, 太原理工大学** |

## Symposium 07: Graduate Student Forum

| Time | No. | Report Title & Speaker |
|---|---|---|
| 14:45 – 14:55 | 10 | Ir-Based Catalysts for Efficient PEMWE Hydrogen Production<br>**王暄胜, 太原理工大学** |
| 14:55 – 15:05 | 11 | Synergistic Engineering of Single Atoms and Defects for Selective Photocatalytic Oxidation of Methane to Value-Added Chemical Products<br>**孙凯, 天津大学** |
| 15:05 – 15:15 | 12 | Steering Intermediate Adsorption with Dual-Site PtMo/C Catalysts for Efficient Alkaline Hydrogen Evolution<br>**曲悠扬, 太原理工大学** |
| 15:15 – 15:25 | 13 | Parallel Microfluidic Synthesis of High-Entropy Alloy Nanoparticles: High-Throughput Preparation and Hydrogen Electrocatalysis<br>**马新航, 广西大学** |
| **Coffee Break · 茶歇 15:25 – 15:35** | | |
| 15:35 – 15:45 | 14 | Biaxial Strain-Engineered Pt-Sulfur Vacancy Dual Active Sites in $Pt/MoO_2@MoS_2$ Architectures for pH-Universal Hydrogen Evolution<br>**袁仓, 北京科技大学** |
| 15:45 – 15:55 | 15 | Highly Sensitive All-Polymer Short-Wavelength Infrared Photodetectors for Complementary Metal Oxide Semiconductor Integrated Imaging Enabled by Dual-Acceptor n-Type Polymers<br>**王玉璞, 天津大学** |
| 15:55 – 16:05 | 16 | Long-Focal-Length Planar Focusing of Anisotropic Plasmons in Two-Dimensional $MoOCl_2$/Au Heterostructures<br>**赵鉴侨, 清华大学** |
| 16:05 – 16:15 | 17 | High-Performance Stretchable Composite Electrodes for Intrinsically Stretchable Organic Photovoltaic Cells and Sensors<br>**韩德霞, 天津大学** |
| 16:15 – 16:25 | 18 | Study on STE Properties of Lead-Free $Cs_2ZrCl_6$ Scintillators Regulated by $Bi^{3+}/Mn^{2+}$<br>**方婉婷, 中国地质大学（北京）** |

## Symposium 07: Graduate Student Forum

| Time | No. | Report Title & Speaker |
|---|---|---|
| 16:25 – 16:35 | 19 | Design and Performance of Mineral-Structured Luminescent Materials for Pressure Sensing<br>**吴兆桀, 中国地质大学（北京）** |
| 16:35 – 16:45 | 20 | New Manufacturing Strategy of Thickening Pipe End by Surfacing Welding to Eliminate the Harmful Effect of Softened Zone in X80 Girth Welded Joint<br>**郑震旦, 天津大学** |
| 16:45 – 16:55 | 21 | Additive Manufacturing of Porous AlSi10Mg Material by Laser Powder Bed Fusion and Analysis of Pore Characteristics<br>**马硕琛, 北京工业大学** |
| 16:55 – 17:05 | 22 | Selective Laser Melting of Cu-Reinforced AlSi10Mg Alloys and Their Triply Periodic Minimal Surface Structures<br>**王畅, 北京工业大学** |
| 17:05 – 17:15 | 23 | Local Dry Underwater TIG Welding for Repairing Spent Fuel Pool Walls<br>**周飞鸿, 北京工业大学** |
| 17:15 – 17:25 | 24 | Synergistic Improvement of Microstructure and Properties of Laser-Arc Hybrid Welded Mg Alloy via Carbon Nanotubes and Oscillating Laser Beam<br>**高永康, 天津大学** |
| 17:25 – 17:35 | 25 | Interface-Modulated Transition from {332} Twinning to Martensitic Banding in Metastable Ti-6Mo-3.5Cr-1Zr Alloy<br>**张飞, 北京理工大学** |
| 17:35 – 17:45 | 26 | Electrical Double Layer Dynamics Regulation for Maximized Electrostatic Energy Harvesting<br>**李志伟, 中国科学院北京纳米能源与系统研究所** |
| 17:45 – 17:55 | 27 | Multifunctional Lignin-Based Anticorrosive Coatings for Metal Protection<br>**冯炜翔, 广东工业大学** |
| 17:55 – 18:05 | 28 | Direct Ink Writing and Multiscale Structural Design of Hybrid Aerogels for Advanced Thermal Management and Acoustic Meta-Devices<br>**李尧, 海军工程大学** |

| Symposium 07: Graduate Student Forum | | |
|---|---|---|
| **Time** | **No.** | **Report Title & Speaker** |
| 18:05 – 18:15 | 29 | Vacancy-Migration-Enabled, Two-Dimensional Gate-Free Neuromorphic Devices for High-Temperature Applications<br>**武程辉, 清华大学** |
| 18:15 – 18:25 | 30 | AI-Enabled Dynamic Analysis and Phase Transition Identification of Magnetic Skyrmion Lattices<br>**路尚润, 北京大学** |

# 专题论坛

## SPECIAL·TOPIC·FORUMS

超导材料 · 二维材料

03

AI EMPOWERMENT · MATERIALS INNOVATION · INTELLIGENT MANUFACTURING

# Special Topic Forum S01

# Superconducting Materials

专题论坛一：超导材料 · 会议程序

| | |
|---|---|
| **Date：** | November 07 – 08, 2026 · Saturday – Sunday |
| **Time：** | 14:00 – 17:35 (UTC+8) · Daily |
| **Venue：** | 2F, Kuiyue Pavilion (葵月阁) |

## Forum Chairs · 论坛主席



**Haihu Wen 闻海虎**
Nanjing University



**Jinxing Zheng 郑金星**
Hefei Institutes of Physical Science, CAS



**Huajun Liu 刘华军**
Hefei Institutes of Physical Science, CAS



**Qingquan Qiu 邱清泉**
Institute of Electrical Engineering, CAS



**Nadezda Panarina**
Editor-in-Chief, Nanophotonics, Wiley

## — DAY 1 · NOVEMBER 07, 2026 (SATURDAY) —

### Special Topic Forum S01: Superconducting Materials

| Time | No. | Report Title & Speaker |
|---|---|---|
| **Session Chairs: Haihu Wen (Nanjing University) · Hongwei Gu (Institute of Electrical Engineering, CAS)** | | |
| **Society Leaders Address ·** | | **13:50 – 14:00** |
| 14:00 – 14:30 | **01** | Inspiration and Perspective from the Commonality of Three Type Unconventional High Temperature Superconductors (Keynote)<br>**Haihu Wen, Nanjing University, China** |
| 14:30 – 14:50 | **02** | Quantum Griffiths Singularity in Superconductors: A 10-year Overview (Invited)<br>**Jian Wang, Peking University, China** |
| 14:50 – 15:10 | **03** | Advances in High-Field HTS Magnet Technology for Next-Generation Particle Accelerators (Invited)<br>**Qingjin Xu, Institute of High Energy Physics (IHEP), CAS, China** |
| 15:10 – 15:30 | **04** | Key Technologies and Challenges of Superconducting Magnets for Magnetic Confinement Fusion (Invited)<br>**Jinxing Zheng, Hefei Institutes of Physical Science (HFIPS), CAS, China** |
| **Coffee Break · 茶歇** | | **15:30 – 15:45** |
| **Session Chairs: Jinxing Zheng (HFIPS, CAS) · Qingjin Xu (IHEP, CAS)** | | |
| 15:45 – 16:05 | **05** | Applications and Challenges of Superconductors in Fusion Magnets (Invited)<br>**Fang Liu, Institute of Plasma Physics, CAS, China** |
| 16:05 – 16:35 | **06** | A Surrogate Model for High-Temperature Superconducting Magnets to Predict Current Distribution with Neural Networks (Invited)<br>**Timing Qu, Fudan University, China** |
| 16:35 – 16:55 | **07** | Title: Study on Loss and Temperature Characteristics of 10 kV Three-Phase Coaxial High-Temperature Superconducting Cables (Invited)<br>**Jin Fang, Beijing Jiaotong University, China** |
| 16:55 – 17:15 | **08** | Recent Progress of High-Temperature Superconducting Pinning Maglev |

| | | |
|---|---|---|
| | | (Invited)<br>**Zigang Deng, Southwest Jiaotong University, China** |
| 17:15 – 17:30 | **09** | Low-Temperature Processing and Doping Optimization of MgB2 Superconductors (Oral)<br>**Jinghan Gao, Affiliation: To Be Confirmed** |
| 17:30 – 17:45 | **10** | Physical Properties of Rare-Earth-Tuned Kagome Materials (Oral)<br>**Xiaofan Yang, Affiliation: To Be Confirmed** |

**Dinner · 晚宴　19:00 · 豪生厅 (Haosheng Hall)**

## DAY 2 · NOVEMBER 08, 2026 (SUNDAY)

### Special Topic Forum S01: Superconducting Materials

| Time | No. | Report Title & Speaker |
|---|---|---|
| **Session Chairs: Huajun Liu (HFIPS, CAS) · Xihua Zong (Shanghai Electric Cable Research Institute Co., Ltd.)** | | |
| 14:00 – 14:20 | **01** | Progress in Research on the Shanghai 110 kV/8 km Superconducting Cable Power Transmission Project (Invited)<br>**Xihua Zong, Shanghai Electric Cable Research Institute Co., Ltd., China** |
| 14:20 – 14:40 | **02** | Research on High-Temperature Magnet Cooled by Dielectric at 50 K (Invited)<br>**Qingquan Qiu, Institute of Electrical Engineering, CAS, China** |
| 14:40 – 15:00 | **03** | High-Field and Reentrant Superconductivity in UTe2 (Invited)<br>**Toni Helm, High Magnetic Field Laboratory (HLD-EMFL), Helmholtz-Zentrum Dresden-Rossendorf, Germany** |
| 15:00 – 15:20 | **04** | Epitaxy of FeAs-based Heterostructures and Interface Superconductivity (Invited)<br>**Canli Song, Tsinghua University, China** |
| **Coffee Break · 茶歇　15:20 – 15:45** | | |
| **Session Chairs: Qingquan Qiu (IEE, CAS) · Chuanbing Cai (Shanghai University)** | | |
| 15:45 – 16:05 | **05** | The Current Situation of Industrialization Development of High-Temperature Superconducting Tapes (Invited) |

| | | |
|---|---|---|
| | | **Chuanbing Cai, Shanghai Creative Superconductor Technologies Co., Ltd. & Shanghai University, China** |
| 16:05 – 16:25 | **06** | Progress in Research of Practical Superconducting Materials (Invited)<br>**Qiang Guo, Western Superconducting Technologies Co., Ltd., China** |
| 16:25 – 16:45 | **07** | Scaling-up and R&D of 2G-HTS Tapes at Shanghai Superconductor Technology (Invited)<br>**Jiamin Zhu, Shanghai Superconductor Technology Co., Ltd., China** |
| 16:45 – 17:05 | **08** | The Research and Industrialization Progress of 2G-HTS Tapes Based on MOCVD Technology in China (Invited)<br>**Yulei Chen, East Superconducting Technology, China** |
| 17:05 – 17:20 | **09** | Scalable Production of PLD-Grade REBCO Superconducting Targets: Phase Purity, Carbon Control and Coated-Conductor Performance (Oral)<br>**Lei Shi, Affiliation: To Be Confirmed** |
| 17:20 – 17:35 | **10** | Effect of Xe Ion Irradiation with Different Energies on the Superconducting Properties of Y(Gd)BCO（不同能量 Xe 离子辐照对 Y(Gd)BCO 的超导性能影响） (Oral)<br>**Hao Yu, Affiliation: To Be Confirmed** |
| 17:35 – 17:50 | **11** | Supersaturation-Driven Defect Engineering for Enhanced Flux Pinning in FF-MOD YBCO Films via Yttrium Stoichiometry Control (Oral)<br>**Jiangtao Shi, Affiliation: To Be Confirmed** |
| **Dinner · 晚餐** | | |

# Special Topic Forum S02

# 2D Materials

专题论坛二：二维材料 · 会议程序

| | |
|---|---|
| **Date:** | November 07 – 08, 2026 · Saturday – Sunday |
| **Time:** | 13:30 – 18:40 (UTC+8) · Daily |
| **Venue:** | Fengye Hall (枫叶厅) |

## Forum Chairs · 论坛主席



**Jiadong Zhou 周家东**
Beijing Institute of Technology



**Rongming Wang 王荣明**
University of Science and Technology Beijing



**Xiaoxu Zhao 赵晓续**
Peking University



**Jinshui Miao 苗金水**
Shanghai Institute of Technical Physics, CAS



**Taotao Li 李涛涛**
Nanjing University



**Yao Zhou 周遥**
Beijing Institute of Technology



**Hu Liu 刘虎**
Qinghai Salt Lake Institute, CAS



**Ziyi Guo 郭子艺**
Deputy Editor, Advanced Science, Wiley

## — DAY 1 · NOVEMBER 07, 2026 (SATURDAY) —

### Special Topic Forum S02: 2D Materials

| Time | No. | Report Title & Speaker |
|---|---|---|
| **Session Chairs: Xidong Duan (Hunan University) and Kai Liu (Tsinghua University)** | | |
| 13:30 – 13:50 | 01 | Phase Engineering of Nanomaterials (PEN): 2D Materials (Keynote)<br>**Hua Zhang, City University of Hong Kong, Hong Kong, China** |
| 13:50 – 14:10 | 02 | 面向先进制程应用的二维半导体器件技术 (Keynote)<br>**Han Wang, The University of Hong Kong, Hong Kong, China** |
| 14:10 – 14:30 | 03 | High-Pressure Modulation of Optoelectronic Properties in Layered Van der Waals Materials (Keynote)<br>**Bingbing Liu, Jilin University, China** |
| 14:30 – 14:50 | 04 | Discovering Novel Magnetic Phases via Magnetic Force Theory and AI-Driven Materials Design (Keynote)<br>**Myung-Joon Han, Korea Advanced Institute of Science and Technology, South Korea** |
| 14:50 – 15:05 | 05 | Reliability of 2D Materials: Linking Device Instabilities to Microscopic Defects (Invited)<br>**Dominic Waldhör, Vienna University of Technology, Austria** |
| **Coffee Break · 茶歇 15:05 – 15:30** | | |
| **Session Chairs: Hua Zhang (City University of Hong Kong) and Han Wang (The University of Hong Kong)** | | |
| 15:30 – 15:50 | 06 | 二维半导体的掺杂调控与高性能神经形态器件 (Keynote)<br>**Kai Liu, Tsinghua University, China** |
| 15:50 – 16:10 | 07 | Controlled Synthesis of 2D Metal Oxides (Keynote)<br>**Dechao Geng, Tianjin University, China** |
| 16:10 – 16:30 | 08 | 二维半导体晶体管的单晶范德华栅介质原位集成 (Keynote)<br>Xidong Duan, Hunan University, China |
| 16:30 – 16:45 | 09 | Interfacial Modulated van der Waals Heterostructures and Intelligent Optoelectronic Applications (Invited)<br>**Shoujun Zheng, Beijing Institute of Technology, China** |

| | | |
|---|---|---|
| 16:45 – 17:00 | **10** | Towards Post-Moore Electronics: 2D Semiconductor Materials and Device Technologies (Invited)<br>**Na Li, Songshan Lake Materials Laboratory, China** |
| 17:00 – 17:15 | **11** | 高介电、超薄单晶栅介质的创制及其二维电子器件 (Invited)<br>**Hua Xu, Shaanxi Normal University, China** |
| 17:15 – 17:30 | **12** | Two-Dimensional Metallic Catalysts for Hydrogen–Electricity Conversion (Invited)<br>**Xiaoqiang Cui, Jilin University, China** |
| 17:30 – 17:42 | **13** | A Family of Ultrathin Non-van der Waals Kamiokite-Type Oxides for Two-Dimensional Electronics (Oral)<br>**Run Shi, Tsinghua University, China** |
| **Dinner · 晚餐 18:30** | | |

## DAY 2 · NOVEMBER 08, 2026 (SUNDAY)

### Special Topic Forum S02: 2D Materials

| Time | No. | Report Title & Speaker |
|---|---|---|
| **Session Chairs: Rongming Wang (University of Science and Technology Beijing) and Fucai Liu (University of Electronic Science and Technology of China)** | | |
| 13:30 – 13:50 | **01** | Van der Waals Layered MoSi2N4 Materials Family (Keynote)<br>**Wencai Ren, Institute of Metal Research, CAS, China** |
| 13:50 – 14:10 | **02** | A Superconducting Diode with Altermagnetic Memory (Keynote)<br>**Weibo Gao, Nanyang Technological University, Singapore** |
| 14:10 – 14:30 | **03** | 二维晶体与光学器件研究 (Keynote)<br>**Kaihui Liu, Peking University, China** |
| 14:30 – 14:50 | **04** | 二维硫化物半导体的晶圆级制备和应用研究 (Keynote)<br>**Yanfeng Zhang, Peking University, China** |
| 14:50 – 15:05 | **05** | Confined Synthesis and Heterogeneous Integration of 2D Materials (Invited)<br>**Lixing Kang, Suzhou Institute of Nano-Tech and Nano-Bionics, CAS, China** |

**Coffee Break · 茶歇　15:05 – 15:30**

**Session Chairs: Wencai Ren (Institute of Metal Research, CAS) and Weibo Gao (Nanyang Technological University)**

| | | |
|---|---|---|
| 15:30 – 15:50 | **06** | Atomic-Scale Imaging and Control of Formation Pathways and Interface Evolution in Two-Dimensional Materials (Keynote)<br>**Rongming Wang, University of Science and Technology Beijing, China** |
| 15:50 – 16:10 | **07** | Unconventional Ferroelectricity at Two-Dimensional Limit (Keynote)<br>**Fucai Liu, University of Electronic Science and Technology of China, China** |
| 16:10 – 16:30 | **08** | 先进超快电子显微镜研制及应用 (Keynote)<br>**Xuewen Fu, Nankai University, China** |
| 16:30 – 16:45 | **09** | Ultrafast Growth of Two-Dimensional Single Crystals via Oriented Attachment on a Molten Surface (Invited)<br>**Li Lin, Peking University, China** |
| 16:45 – 17:00 | **10** | 二维金属间化合物和高熵金属合金的吸附-转化制备 (Invited)<br>**Peng Zhang, Beihang University, China** |
| 17:00 – 17:15 | **11** | 二维插层超晶格的化学设计合成与量子物性调控 (Invited)<br>**Jingyuan Zhou, Nankai University, China** |
| 17:15 – 17:30 | **12** | Kinetic Acceleration of MoS2 Growth by Oxy-Metal-Organic Chemical Vapor Deposition (Invited)<br>**Lei Liu, Suzhou Laboratory, China** |
| 17:30 – 17:45 | **13** | 二维材料异质界面电子结构调控与高效电解水催化应用 (Invited)<br>**Tianyu Xia, Zhengzhou University, China** |

**Dinner · 晚餐**

# 期刊活动

## JOURNAL·EVENTS

National Materials · SmartSys · c-Science · Wiley 编辑面对面

04

AI EMPOWERMENT · MATERIALS INNOVATION · INTELLIGENT MANUFACTURING

# National Materials Symposium·

National Materials 专题论坛 · 会议程序

| | |
|---|---|
| **Date：** | November 07, 2026 · Saturday |
| **Time：** | 14:00 – 17:30 (UTC+8) |
| **Venue：** | 1F, Taishan Hall (泰山厅) |

## Forum Chairs · 论坛主席



**Jin Zhang 张锦**
Peking University



**Shaojun Guo 郭少军**
Peking University

## — NOVEMBER 07, 2026 (SATURDAY) · 14:00 – 17:30 —

**National Materials** Symposium

| Time | No. | Report Title & Speaker |
|---|---|---|
| | | **Session Chair: Shaojun Guo (Peking University)** |
| | | **Opening & Journal Introduction · 开场与期刊简介 14:00 – 14:05** |
| 14:05 – 14:35 | 01 | Perovskite/Silicon Tandem Photoelectrode Modules for Practical Solar Hydrogen Production (Keynote)<br>**Jae Sung Lee, Ulsan National Institute of Science and Technology (UNIST), South Korea** |
| 14:35 – 15:05 | 02 | Defect- and Interface-Engineering of Energy-Functional 2D Nanohybrids (Keynote)<br>**Seong Ju Hwang, Yonsei University, South Korea** |
| 15:05 – 15:35 | 03 | From Photocatalysis to Photon-Phonon Co-driven Catalysis (PPCC) (Keynote)<br>**Junwang Tang 唐军旺, Tsinghua University, China** |
| | | **Group Photo & Coffee Break · 合照茶歇 15:35 – 16:00** |
| | | **Session Chair: Shaojun Guo (Peking University)** |
| 16:00 – 16:30 | 04 | The Role of Materials Chemistry in Energy Storage and Conversion (Keynote)<br>**Nicola Pinna, Humboldt University of Berlin, Germany** |
| 16:30 – 17:00 | 05 | Quantum Light from van der Waals Materials: Single Photons and Strain-Programmable Entangled Photon Pairs (Keynote)<br>**Weibo Gao 高炜博, Nanyang Technological University, Singapore** |
| 17:00 – 17:30 | 06 | Dynamic Structure in Adsorption and Catalysis by Porous Materials (Keynote)<br>**Sihai Yang 杨四海, Peking University, China** |
| | | **End of Session · 本场次报告结束 17:30** |

# SmartSys Editorial Board and Symposium

SmartSys 编委会暨研讨会 · 会议议程

| | |
|---|---|
| **Date:** | November 08, 2026 · Sunday |
| **Time:** | 15:30 – 17:00 (UTC+8) |
| **Venue:** | 1F, Taishan Hall (泰山厅) |

## Forum Chairs · 论坛主席



**Zhong Lin Wang 王中林**

Editor-in-Chief, SmartSys; Beijing Institute of Nanoenergy and Nanosystems, CAS



**Junyi Zhai 翟俊宜**

Associate Editor-in-Chief, SmartSys; Beijing Institute of Nanoenergy and Nanosystems, CAS

**编委同心 · 共创期刊未来**

## — NOVEMBER 08, 2026 (SUNDAY) · AFTERNOON —

| SmartSys Editorial Board and Symposium | | | |
|---|---|---|---|
| **时间 Time** | **环节 Session** | **内容 Content** | **负责人 / 主持 Host** |
| **Session Chairs: Zhong Lin Wang (BINN, CAS) · Junyi Zhai (BINN, CAS)** | | | |
| 15:00 – 15:30 | **签到入场 Registration** | 就座；期刊视频播放 | 编辑部 Editorial Office |
| 15:30 – 15:40 | **开场致辞 Opening Remarks** | 欢迎致辞；半天会议目标 | 副主编翟俊宜主持 Hosted by Assoc. Editor-in-Chief Junyi Zhai |
| 15:40 – 16:00 | **期刊进展报告 Journal Progress Report** | 7 期成果、 Scopus 收录、 ESCI 路线、关键数据与编委支持事项 | 编辑部 Editorial Office |
| 16:00 – 16:45 | **研讨会 Symposium** | 期刊专题讨论与影响力提升计划 | 副主编翟俊宜主持 Hosted by Assoc. Editor-in-Chief Junyi Zhai |
| 16:45 – 17:00 | **颁奖与合影 Awards & Group Photo** | 优秀青年编委 6 位（ 5 位线下）颁奖与合影 | 主编颁奖 Presented by Editor-in-Chief |
| **End of Meeting · 会议结束 17:00** | | | |

# cScience Forum

cScience 专题论坛 · 论坛介绍

## Forum Chairs • 论坛主席



**Xinmei Hou 侯新梅**

University of Science and Technology Beijing · 北京科技大学

## 论坛简介 • About the Forum

本分论坛专注“双碳”可持续发展的研究，涉及绿色低碳、智能资源、清洁能源、碳催化以及材料、资源、化学、能源、环境等跨学科领域的应用。

联系人 Contact · 冯寅楠 13466608571

# Wiley Meet the Editors

主编面对面 · 一对一咨询

| | |
|---|---|
| **Date:** | November 07 – 08, 2026 · Saturday – Sunday |
| **Time:** | 15:00 – 17:00 (UTC+8) · 每人 15 分钟 |
| **Venue:** | Songshan Hall (嵩山厅) |

## 活动目的 • PURPOSE

研究人员可预约与 Wiley 编辑进行一对一交流。每位作者将拥有 15 分钟专属咨询时间，与编辑深入讨论研究工作、目标期刊选择及稿件准备等问题。为帮助匹配最适合的编辑，参与者需提前提交研究摘要，主办方将根据研究方向安排交流时段。

## 活动亮点 • HIGHLIGHTS

- 与 Wiley 资深编辑面对面交流
- 获取投稿策略与期刊选择建议
- 了解期刊关注的研究方向与出版趋势
- 就正在准备或已完成的研究成果获得专业意见
- 拓展与国际学术出版团队的联系

无论您正在准备投稿、寻求合适的发表平台，还是希望深入了解学术出版流程，都欢迎参加本次“编辑面对面”活动，与 Wiley 编辑团队展开交流。

| Wiley Meet the Editors · One-on-One Sessions | |
|---|---|
| **编辑 Editor** | **职务 Position** |
| **Esther Levy** | Editor-in-Chief, Advanced Materials |
| **Joern Ritterbusch** | Editor-in-Chief, Advanced Functional Materials |
| **Till Graberg** | Editor-in-Chief, Advanced Energy Materials |
| **Richard Murray** | Editor-in-Chief, Advanced Intelligent Systems;<br>Deputy Editor, Advanced Science |
| **Nadezda Panarina** | Editor-in-Chief, Nanophotonics |
| **Partha Pal** | Deputy Editor, Chemistry – An Asian Journal |
| **梁多多** | Deputy Editor, Advanced Materials;<br>Editor-in-Chief, Advanced Photonics Research |
| **翁博** | Deputy Editor, Advanced Materials;<br>Editor-in-Chief, Macromolecular Rapid Communications |
| **温茜** | Editor-in-Chief, Small Methods; Deputy Editor, Small |
| **李佳琪** | Deputy Editor, Advanced Science (Artificial Intelligence) |
| **杨涛** | Deputy Editor, Advanced Science (Bio-Nanoscience) |
| **祖萌（Alick Zu）** | Deputy Editor, Advanced Science (Electronic Devices) |
| **郭子艺** | Deputy Editor, Advanced Science (Materials Engineering) |

# 墙报展示

## POSTER·SESSIONS

墙报交流 · 墙报清单 P-01 – P-56 · 主题索引

05

AI EMPOWERMENT · MATERIALS INNOVATION · INTELLIGENT MANUFACTURING

# Poster Presentation

墙报展示 · 会议程序

| | |
|---|---|
| **Date:** | November 06 – 08, 2026 · Friday – Sunday |
| **Time:** | Nov 6 16:30 – 18:00 · Nov 7–8 15:00 – 17:00 |
| **Venue:** | Poster Area (墙报区) |

## 1. Poster Session Schedule

All posters (P-01 – P-58) will be on display for the full duration of the three poster sessions listed below. Presenters are requested to stand by their boards during the sessions to present and discuss their work with conference participants.

| | | |
|---|---|---|
| **Poster Session I** | Friday, 6 November 2026 | 16:30 – 18:00 |
| **Poster Session II** | Saturday, 7 November 2026 | 15:00 – 17:00 |
| **Poster Session III** | Sunday, 8 November 2026 | 15:00 – 17:00 |

## 2. Notes for Presenters

1. Each poster has been assigned a board number (P-01 – P-58). Please mount your poster on the board bearing your assigned number, which will also be listed in this programme.
2. Poster board numbers are grouped by session topic (Section 5) to facilitate on-site browsing. Please check the on-site signage for the exact location of your board.
3. Poster format, board dimensions, and mounting/removal times will be announced separately by the Organizing Committee.
4. Presenters are responsible for removing their posters after the final session. Posters left on boards after the removal deadline will be discarded.
5. Presenters with outstanding registration payment are kindly requested to complete payment at the registration desk before their session.

## 3. Poster Distribution by Topic

| | |
|---|---|
| Symposium 01 · Advanced Materials & AI Empowerment | **3** posters |
| Symposium 03 · Intelligent Sensing & Next-Gen AI | **14** posters |
| Symposium 04 · Medical–Engineering & Intelligent Materials | **12** posters |
| Symposium 05 · New Energy & Green Manufacturing | **8** posters |
| Symposium 07 · Graduate Student | **16** posters |
| Special Topic Forum S01 · Superconducting Materials | **4** posters |
| Special Topic Forum S02 · Two-Dimensional Materials | **1** poster |

## 4. Poster List (P-01 – P-58)

| NO. | POSTER TITLE | PRESENTER | TOPIC / SYMPOSIUM |
|---|---|---|---|
| P-01 | Self-powered bioelectronic medicine targeting the gut-kidney axis via low-level vagus nerve stimulation mitigates kidney damage | 任盼星 | Symposium 04 · Medical–Engineering & Intelligent Materials |
| P-02 | Injectable biomimetic lymphatic niches enable in vivo T-cell programming | 林靓茹 | Symposium 04 · Medical–Engineering & Intelligent Materials |
| P-03 | Flexible p–n Thermoelectric Sensors with a High Seebeck Coefficient and 0.001 K Resolution | 徐星荷 | Symposium 07 · Graduate Student |
| P-04 | Low-Threshold Hybrid Wave Energy Harvesting via Nonlinear Multistage Coupling | 许雅雅 | Symposium 03 · Intelligent Sensing & Next-Gen AI |
| P-05 | p-NiO Gate Stack Combined with Pre-Fluorine Treatment for High-Performance E-mode AlGaN/GaN HEMTs | 许特 | Symposium 03 · Intelligent Sensing & Next-Gen AI |
| P-06 | Immobilized Phage-enhanced Probiotics Competition by Spatial Niche Reallocation Permits Precise Bacteria Replacement | 罗俊 | Symposium 04 · Medical–Engineering & Intelligent Materials |
| P-07 | Multilayer Electromagnetic–Thermal Coupling Simulation of Stacked HTS Tapes | 吕佳诺 | Special Topic Forum S01 · Superconducting Materials |
| P-08 | In situ grown Co-intercalated $MnO_2$ on 3D lignin-based carbon nanoflowers for high-performance aqueous zinc-ion batteries | 张译文 | Symposium 07 · Graduate Student |
| P-09 | Thermal-exposure-induced microstructural evolution and wear–corrosion degradation of laser-remelted 3533-00 high-Cr-Ni-Mo Fe-based coatings | 史强 | Symposium 07 · Graduate Student |
| P-10 | Synergistic Enhancement of Magnetorheological Fluid Sedimentation Stability via Plasma Surface Engineering and Micro–Nano Dual-Dispersed Particles | 郑长宽 | Symposium 04 · Medical–Engineering & Intelligent Materials |
| P-11 | A Helical Copper Former for CORC Cables: Reduced Eddy-Current Loss and Enhanced Liquid-Nitrogen Cooling | 姜明浩 | Special Topic Forum S01 · Superconducting Materials |

| NO. | POSTER TITLE | PRESENTER | TOPIC / SYMPOSIUM |
|---|---|---|---|
| P-12 | Adjusting the microstructure of $FeNi_3/C$ by controlling the carbon addition to optimize the electromagnetic wave absorption performance | 索幸 | Symposium 01 · Advanced Materials & AI Empowerment |
| P-13 | Structural Evolution and Property Analysis of Al–N–O–Si Quaternary Ceramic Materials | 李纪河 | Symposium 07 · Graduate Student |
| P-14 | A Novel Magnetic Relaxation Time Sensing Technology Based on Manganese Compounds | 黄晓晓 | Symposium 04 · Medical–Engineering & Intelligent Materials |
| P-15 | Relaxor Ferroelectric Thermoplastic Elastomers: Combining High Permittivity and Low Modulus for Conformal Electroadhesion | Dongjun Lee | Symposium 07 · Graduate Student |
| P-16 | A Library of Dipolar Skyrmion Bags Observed in a Centrosymmetric van der Waals Magnet | 胡玥 | Special Topic Forum S02 · Two-Dimensional Materials |
| P-17 | SuFEx-Enabled Sulfonylimide-Functionalized Polymer Binders for Simultaneous $Li^+$ Transport and Adhesion in Silicon Anodes | Sejeong Moon | Symposium 05 · New Energy & Green Manufacturing |
| P-18 | Comparative Study of the Phase Behavior and Rheology of PEC (Polyelectrolyte Complex) and PAC (Polyampholyte Complex) | Gyu Min Yim | Symposium 07 · Graduate Student |
| P-19 | Bioinspired Piezoionic Hydrogels toward Adaptive Tactile Sensing and Object Recognition | 王舒妤 | Symposium 03 · Intelligent Sensing & Next-Gen AI |
| P-20 | Recoverable Macroporous Polyanion Bead Catalysts for Efficient Chemical Depolymerization of Polyesters and Their Composites | Yongsu Kim | Symposium 07 · Graduate Student |
| P-21 | Intelligent Tribotronic Transistors Toward Tactile Near-Sensor Computing | 雷浩 | Symposium 03 · Intelligent Sensing & Next-Gen AI |
| P-22 | Flow induced lamellae orientation dominates cavitation in injection-molding polypropylene | 陈友绪 | Symposium 07 · Graduate Student |
| P-23 | Chemically Gated Electrical Writing in Polyelectrolyte Hydrogel Memristors via Matching Water Affinities | Jowon Shin | Symposium 07 · Graduate Student |
| P-24 | Effect of Si alloying on microstructure and mechanical properties of Mg-Y-Zn alloys with LPSO phases | 路绚铮 | Symposium 07 · Graduate Student |

| NO. | POSTER TITLE | PRESENTER | TOPIC / SYMPOSIUM |
|---|---|---|---|
| P-25 | Formaldehyde Degradation by Soft-Sliding-Electrification Induced Air Ionization | 魏一晗 | Symposium 03 · Intelligent Sensing & Next-Gen AI |
| P-26 | Constructing Amorphous/Crystalline Heterointerface for Oxygen Evolution Reaction | 王超伟 | Symposium 05 · New Energy & Green Manufacturing |
| P-27 | Effects of Cu addition and Er–Zr microalloying on the hot tearing susceptibility of Al–30Zn alloys | 张松涛 | Symposium 07 · Graduate Student |
| P-28 | Effect of Si and Er additions on interfacial reactions in Fe/Al laminated composites | 王振 | Symposium 01 · Advanced Materials & AI Empowerment |
| P-29 | Asymmetric Ferroelectric Gated Reconfigurable $WSe_2$ p–n Homojunction for In-Sensor Neuromorphic Vision Processing | 池梦霜 | Symposium 03 · Intelligent Sensing & Next-Gen AI |
| P-30 | PLD growth of $Bi_2O_2Se$ and $Bi_2SeO_5$ | 王一帆 | Symposium 03 · Intelligent Sensing & Next-Gen AI |
| P-31 | Low-Temperature Annealing-Induced Interfacial Reconstruction for Ultra-Low-Resistance Ohmic Contacts in GaN HEMTs | 李瑁 | Symposium 03 · Intelligent Sensing & Next-Gen AI |
| P-32 | Fin-Coupled Rolling-Ball Triboelectric Nanogenerator for Low-Speed Ocean Current Energy Harvesting and Flow Sensing | 莫怡嫣 | Symposium 03 · Intelligent Sensing & Next-Gen AI |
| P-33 | Single-Atom Iridium Orchestrates a Reaction Pathway Shift to Activate Lattice Oxygen for Efficient Oxygen Evolution | 段忠辛 | Symposium 05 · New Energy & Green Manufacturing |
| P-34 | Multimodal Artificial Synapses Based on the Tribovoltaic–Optical Coupling Effect | 段彬 | Symposium 03 · Intelligent Sensing & Next-Gen AI |
| P-35 | Arch-Driven Gradient Design for Additively Manufactured Bone Implant Scaffolds | 李天祥 | Symposium 04 · Medical–Engineering & Intelligent Materials |
| P-36 | Machine Learning-Guided Construction of a Microenvironment-Regulated Cascade Reaction System* | 杨光 | Symposium 03 · Intelligent Sensing & Next-Gen AI |

| NO. | POSTER TITLE | PRESENTER | TOPIC / SYMPOSIUM |
|---|---|---|---|
| P-37 | Gold-Iron Phosphide Nanoreactor for Enhanced Lung Cancer Radiotherapy via the Caveolae Pumping System | 张琳 | Symposium 04 · Medical–Engineering & Intelligent Materials |
| P-38 | Flow-Induced Crystallite Evolution in Polybutene-1 Copolymers: Bidirectional Acceleration/Retardation of Solid-State Phase Transition | 刘英卓 | Symposium 07 · Graduate Student |
| P-39 | Defect Induced Crystal Phase and Kinetically Controlled Transitions in Chemically Recyclable Polythiocarbonates | 高远桥 | Symposium 07 · Graduate Student |
| P-40 | Pre-Regulating Protein Spatial Conformation and Precursor Rigidity for Tailored Biomass Carbons Toward Wastewater Purification and High-Energy Li–S Batteries | 杜真 | Symposium 05 · New Energy & Green Manufacturing |
| P-41 | Spatially Separated Dual-Locked NIR-II Afterglow Probe for Mapping Dynamic $H_2O_2$ and NTR Evolution during Tumor Progression and Therapy | 张维瑶 | Symposium 04 · Medical–Engineering & Intelligent Materials |
| P-42 | High-Torque Dielectric Elastomer Actuator-Driven Soft Robotic Arm for Multi-DoF Manipulation | 马续智 | Symposium 07 · Graduate Student |
| P-43 | AuCu Dual-Site Electrodes with Electronic-Structure Modulation and Interfacial Hydrogen-Bond-Network Regulation for High-Current-Density Glycerol Oxidation | 谭海文 | Symposium 05 · New Energy & Green Manufacturing |
| P-44 | Two-Dimensional Lamellar-Encapsulated Liquid-Metal Core-Shell Fillers and Their Multifunctional Polymer Composites | 张思雨 | Symposium 07 · Graduate Student |
| P-45 | Piezo-mediated inhibition of ferroptosis alleviates acute liver injury | 梁世园 | Symposium 04 · Medical–Engineering & Intelligent Materials |
| P-46 | Construction and Application of 3D-Printed Electrochemical Sensors | 王路军 | Symposium 03 · Intelligent Sensing & Next-Gen AI |
| P-47 | Structural and Magnetic Tuning of Frustrated Magnets | 张传迪 Zhang Chuandi | Special Topic Forum S01 · Superconducting Materials |
| P-48 | Hollow Carbon Spheres Encapsulating $FeSe_2/FeS_2$ Heterostructures for High-Performance Microwave Absorption | 袁美玉 | Symposium 01 · Advanced Materials & AI Empowerment |

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| P-50 | AI-Assisted Mapping of Protein–Heparin Interactions for Pathological Microenvironment-Responsive Coacervates | Yoojin Lee | Symposium 04 · Medical–Engineering & Intelligent Materials |
| P-51 | Precursor-engineered strategy for constructing supported tetra-atom Pt clusters to boost propane dehydrogenation under direct resistive heating | 李盼盼 | Symposium 05 · New Energy & Green Manufacturing |
| P-52 | Monolayer $MoSe_2$–$WSe_2$ Lateral Heterostructures for Reconfigurable Logic Transistors and Low-Threshold Electroluminescence | 马翰原 | Symposium 07 · Graduate Student |
| P-53 | Local Chemical Correlations in Multielement-Doped High-Voltage $LiNi_{0.5}Mn_{1.5}O_4$ Cathodes | 李根鹏 | Symposium 05 · New Energy & Green Manufacturing |
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| P-58 | Topology-Guided Anchoring-Compliance Interface Reconstruction for Dynamically Stable, Kilovolt-Class GaN MIS-HEMTs | 张冀周 | Symposium 03 · Intelligent Sensing & Next-Gen AI |

* Poster title translated from the Chinese original; the English title is to be confirmed by the presenting author.

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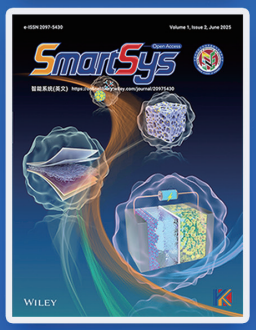


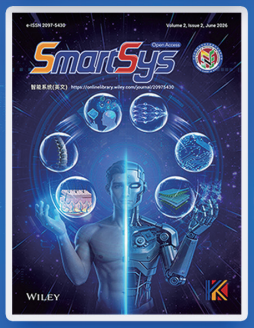
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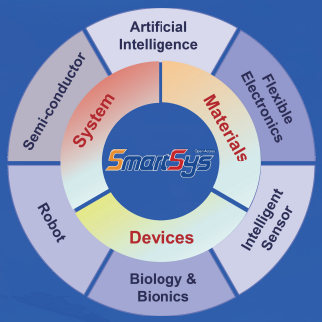
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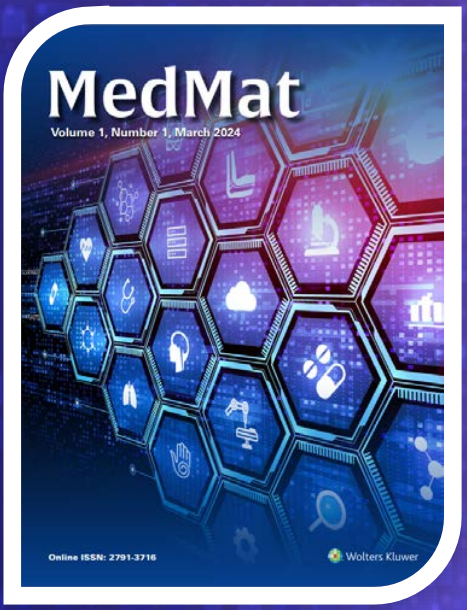


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# 中国发展战略学研究会先进材料与智能制造战略专业委员会介绍

中国发展战略学研究会先进材料与智能制造战略专业委员会，是为响应国家制造强国战略、推动先进材料与智能制造融合发展而成立的学术与产业协同平台及高端智库。专委会聚焦于先进材料与智能制造两大关键领域，致力于通过战略研究、学术交流、产业促进、标准制定、人才培养与国际合作，提升我国在该领域的全球竞争力与创新能力。

专委会由国际知名科学家王中林院士担任主任委员，刘忠范院士、南策文院士、雒建斌院士、林元华院士和李和兴教授等多位顶尖专家担任副主任委员，钱九红教授任秘书长。首批会员汇聚了来自全国高校、科研院所、企业的 133 名高层次会员，其中两院院士 5 人、国家杰青 12 人，长江学者 7 人，人大代表 4 人，约 80%拥有教授、研究员及正高级工程师职称，超过 96%人员拥有博士学位，覆盖先进材料与智能制造全产业链。

工作内容涵盖六大业务板块：战略研究与决策支持、学术交流与成果转化、产业协同与项目孵化、标准制定与行业培训、人才培养与流动促进、国际合作与服务平台建设。专委会依托北京纳米能源与系统研究所作为主办单位，具备雄厚的科研基础、人才资源与产业化支撑。

未来，专委会将建设成为集“战略智库、创新引擎、产业枢纽、人才高地”于一体的国家级平台，推动技术创新、产业协同与标准引领，为我国实现高水平科技自立自强和制造业高质量发展提供坚实支撑。

专委会标志

中国发展战略学研究会 先进材料与智能制造战略专业委员会

# 委员会议程

Agenda for the Committee Meeting of the Special Committee for Advanced Materials and Intelligent Manufacturing Strategy

**会议时间** 11 月 7 日（星期六） 20:30 – 21:30

**会议地点** 君和厅（Junhe Hall）

**参会人员** 王中林院士、雒建斌院士、林元华院士、钱九红秘书长及专委会全体委员

## 会议主要事项 Main Items

1. 梳理总结专委会年度建设工作：汇报专委会 3 月成立以来整体发展情况，总结 ICMIA 大会（专委会成立后首次大型学术会议）举办成果。
2. 举行新晋委员证书颁发仪式。
3. 表彰本年度专委会优秀会员。
4. 集体研讨、审议专委会下一年度重点工作计划与发展安排。
5. 院士总结部署专委会后续重点工作。

## AGENDA

**Time** 20:30 – 21:30, November 7, 2026 **Venue** Junhe Hall

**Attendees** Academician Wang Zhonglin, Academician Luo Jianbin, Academician Lin Yuanhua, Secretary-General Qian Jiuhong and all committee members.

1. Review the development of the Special Committee since its establishment in March, and summarize the outcomes of the ICMIA Conference, the first major academic conference hosted by the Special Committee.
2. Certificate presentation for newly appointed committee members.
3. Commend the outstanding members of the Special Committee for this year.
4. Discuss and deliberate on the key work plan and development arrangements of the Special Committee for the coming year.
5. Remarks by academicians on the follow-up priorities of the Special Committee.

# 国际先进材料与智能制造大会 + 人工智能 2026

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# 摘要集

## Abstract Book

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# 分论坛一

SYMPOSIUM 01 · ADVANCED MATERIALS AND AI EMPOWERMENT

先进材料与人工智能赋能

01

AI EMPOWERMENT · MATERIALS INNOVATION · INTELLIGENT MANUFACTURING

01 KEYNOTE

## Conjugated Oligoelectrolytes: A Versatile Platform for Membrane Modifications

**Prof. Guillermo C. Bazan**

*Nanyang Technological University, Singapore*

Conjugated oligoelectrolytes (COEs) are a class of synthetic molecules characterized by a linear π-conjugated backbone and terminal ionic functionalities. The distribution of hydrophobic and hydrophilic charged groups promotes spontaneous self-assembly within lipid bilayer membranes. This interaction leads to modifications of membrane properties that correlate with the structural features of the COEs. Extended molecular lengths, for example, can induce membrane rigidification while remaining largely non-cytotoxic. These attributes enable the design of molecular probes with tunable optical properties for bioimaging, particularly for the characterization of nanoscale extracellular vesicles. By incorporating internal molecular rotors that modulate non-radiative decay rates, COEs can be engineered to report on membrane composition and tension in living cells, including changes induced by environmental conditions or pharmacological treatments. Our recent efforts have focused on tuning the fluorescence lifetimes of COEs through molecular design, specifically by systematically altering the nature of intramolecular charge-transfer excited states. These properties, combined with compatibility with phasor-based fluorescence lifetime imaging microscopy (FLIM), provide a platform for the simultaneous visualization and quantitative separation of multiple vesicle populations and organelles within shared spectral channels.

02 KEYNOTE

## Nature's Blueprint: Engineering the Next Generation of Bioinspired Hybrid Materials

**Prof. Mato Knez**

*CIC nanoGUNE, Spain*

For centuries, engineers have admired nature’s structural mastery, the unmatched tensile strength of spider silk, the fracture toughness of nacre, and the self-healing power of cellular tissue. Yet synthetic materials rarely achieve this benchmark because replicating nature's hierarchically organized organic-inorganic hybrids at scale is notoriously difficult. This talk demonstrates a transformative solution: bottom-up engineering via vapor-phase chemistry. Under the banner of Atomic Layer Processing (ALP), spanning ALD, MLD, and Vapor Phase Infiltration (VPI), we gain atomic-scale control to program biological capabilities directly into bulk substrates. We will explore how this "modern material alchemy" dramatically toughens polymers, confers durable antimicrobial properties to everyday textiles, and yields resilient, self-repairing flexible electronics. Moving from passive imitation to seamless molecular integration, ALP opens a new frontier in high-performance materials for wearables, soft robotics, and sustainable infrastructure.

03 KEYNOTE

## Physics-Informed AI for Material Characterization and Inverse Design

**Prof. Seunghwa Ryu**

*Korea Advanced Institute of Science and Technology, Korea*

Inverse problems are central to engineering, from identifying material properties from sparse measurements to designing structures with prescribed mechanical responses. In this talk, I will present our recent work on physics-informed neural networks (PINNs) for material characterization, constitutive model discovery, and data-free inverse design of bistable kirigami and origami metamaterials. These studies demonstrate how governing physics can enable accurate inference and design even when experimental data are scarce or noisy. I will also discuss the limitations of PINNs and the importance of choosing how physics is incorporated into the inverse problem. Using pavement modulus backcalculation as an example, I will compare PINNs with differentiable finite element methods, which enforce governing physics directly through a differentiable solver. Together, these studies highlight a broader view of physics-

informed AI that combines learning, automatic differentiation, and numerical solvers for robust and data-efficient engineering inverse problems.

04 KEYNOTE

## Towards single crystals of covalent organic polymers and frameworks

**Prof. Qichun Zhang**

*City University of Hong Kong, Hong Kong, China*

Covalent organic polymers/frameworks (COPs/COFs) have caused many scientists' interest in both fundamental research (synthesis, properties, theoretical simulation, etc.) and possible applications (gas absorption/separation, catalysis, energy-related devices, sensing, imaging, and so on). In this talk, I will present our recent progress on the preparation of novel COPs/COFs single crystals as well as their diverse applications in optoelectrical devices.

05 INVITED

## Ferroelectric Polarization Engineering in Epitaxial ScAlN

**Prof. Ping Wang**

*Peking University, China*

Ferroelectric ScAlN is a promising material for nonvolatile memories, reconfigurable electronics, and multifunctional nitride devices. In this work, we investigate the polarization engineering in fully epitaxial ferroelectric ScAlN/GaN heterostructures grown by plasma-assisted molecular beam epitaxy. By combining atomic-scale structural and spectroscopic characterization with first-principle calculation, we reveal that interfacial dead layer formation and polarization reversal fatigue are closely related to the generation, migration, and accumulation of nitrogen vacancies. These defects preferentially accumulate at strained interfaces and microstructural defects, where they enhance leakage transport and pin ferroelectric domains and domain walls. These findings provide direct microscopic insight into polarization modulation in ScAlN.

06 KEYNOTE

## Title to be announced

**Prof. Wenjun Zhang**

*City University of Hong Kong, Hong Kong, China*

*Abstract not received at the time of printing.*

06 KEYNOTE

## Liquid crystals, photoalignment and battery technology

**Prof. Kristiaan Neyts**

*The Hong Kong University of Science and Technology, Hong Kong, China*

Liquid crystals are molecular liquids with some degree of spontaneous ordering. Their orientation near the surface can be prescribed by illuminating a photosensitive material with linearly polarized UV or blue light. They are widely applied in display devices but can be used in many kinds of photonic components. Recently liquid crystals have been introduced in the electrolyte medium of batteries to improve the charge transport of lithium ions.

07 KEYNOTE

## Hybrid Multifunctional Materials for Emerging Energy Technologies: From Photovoltaics to Neuromorphics

**Prof. Jovana Milic**

*University of Turku, Finland*

Hybrid organic-inorganic framework materials have emerged as one of the most promising semiconductors in optoelectronics.[1] In particular, hybrid halide perovskite materials have demonstrated superior solar-to-electric energy conversion in photovoltaics, while soft yet crystalline mixed ionic-electronic semiconductors with remarkable optoelectronic characteristics.[2,3] However, their limited stability in response to environmental factors and operating conditions of voltage bias and light hampers practical applications.[4] This stems from ion migration, which increases interfacial reactivity and limits stability under device operating conditions.[2] There has been an effort to overcome these shortcomings by developing tailored organic components that template hybrid perovskite frameworks and contribute to their stabilisation through increased hydrophobicity and limited ion permeability, enhancing their performance in optoelectronics.[5,6] We demonstrate the capacity to rely on supramolecular engineering to develop a new generation of hybrid perovskite materials that respond to external stimuli and adapt to their operating conditions, such as by incorporating photochromic systems into 'smart solar cells' that can adapt to day-night cycles.[7] The dynamic control of the underlying ionic migration has set the basis for the utility of these materials in brain-inspired memory elements, as artificial synapses,[8] and self-powered memories for neuromorphic computing,[9] revealing new perspectives for hybrid framework materials, and more sustainable lead- and metal-free systems,[10] in emerging technologies.

08 INVITED

## Designing bioinspired materials via 3D printing and ice-templating

**Prof. Iek Man LEI**

*University of Macau, Macau, China*

Biological materials derive exceptional mechanical and optical functionalities from precisely organized micro-to-nano scaled structures, yet replicating such performance synthetically remains challenging. This presentation highlights two of our recent works that utilize ice-templating and 3D printing to enable bioinspired structural control in soft materials across mechanical and photonic domains. First, we introduce a concentric ice-templating that generates circumferentially aligned fibrous hydrogels, inspired by load-bearing tissues such as intervertebral discs and arteries. By combining slow freezing with rotary compression annealing, these hydrogels achieve a unique combination of high tensile strength, ultra-compressibility (8% residual strain after 500 cycles), and exceptional burst pressure (1.6 bar), while retaining 85 wt.% water content. These structure-derived properties enable soft robotic applications, including pneumatic grippers and an untethered bioinspired robotic fish. Second, we present an aqueous two-phase embedded 3D printing strategy for plant-derived hydroxypropyl cellulose (HPC) to create large-scale, structurally colored materials with high optical fidelity. A low-interfacial-tension, food-grade support medium preserves HPC cholesteric order during printing, limiting reflection wavelength shifts to less than 3% over three days. This approach enables freeform fabrication of intricate photonic architectures with feature sizes down to ~50 μm and consistent coloration over decimeter-scale lengths. The method further supports programmable, non-planar mechanochromic hydrogel actuators for information encryption and human–machine interaction.

09 INVITED

## Autonomous Laboratory for New Materials Development Based on Few-Shot Self-Evolving Agents

**Prof. Shitong Wang**

*Beihang University, China*

Autonomous materials discovery requires reliable integration of scientific reasoning, domain knowledge, and physical experimentation when experimental data are scarce. This presentation introduces the AIA OS framework combining an ontology-based world model, modular minimum execution units (MEUs), and few-shot self-improving agents. The ontology unifies materials, instruments, processes, and experimental data, supporting knowledge integration and traceability. MEUs connect software, interfaces, laboratory equipment, and shared services, translating agent plans into controlled experimental actions. Using limited demonstrations and expert feedback, the agents refine reusable skills and workflows through independent evaluation, with foundation-model parameters kept fixed. Specialist models, active learning, and agent memory connect hypothesis generation, experiment planning, execution, and interpretation within iterative research loops. Examples in energy materials research and autonomous battery testing illustrate this approach, alongside potential extensions to quality control and flexible manufacturing. Researchers remain responsible for defining meaningful questions, evaluating competing explanations, and ensuring reproducibility. This framework outlines a practical route from automated experimentation toward adaptive, goal-directed materials research, with experimental feedback guiding both scientific decisions and the workflows used to implement them.

10 INVITED

## Low-Concentration Nonanal Gas-Sensing Materials for Agricultural Product Storage Monitoring

**Prof. Chao Zhang**

*Yangzhou University, China*

In this study, La-modified $Bi_2O_2CO_3$ (BCO-La) microspheres were synthesized via a facile wet-chemical strategy for the detection of low-concentration nonanal ($C_9H_{18}O$) gas at room temperature. The as-prepared BCO-La gas sensor was subsequently applied to agricultural product quality assessment, specifically for the detection of cooked rice. The results demonstrated that the BCO-6La sensor exhibited significantly better sensing performance than the pristine BCO sensor, achieving a response of 174.6 toward 30 ppm nonanal. Notably, the BCO-6La sensor exhibited a rapid response time of 36 s upon exposure to 18 ppm nonanal. Furthermore, during cooked rice quality assessment, the sensor exhibited a selectivity toward nonanal approximately 4–24 times higher than that toward interfering gases, including 1-octanol, geranyl acetone, linalool, hexanal, 2-pentylfuran, and 1-octen-3-ol. In situ infrared spectroscopy and density functional theory (DFT) analyses were employed to elucidate the gas-sensing mechanism of the BCO-La microspheres and the factors contributing to their enhanced sensing performance. The sensor was also validated under practical detection scenarios. More broadly, the sensor developed in this study provides a novel platform for detecting and monitoring gases released during the storage of agricultural products.

11 ORAL

## Texture-Based Interlayer Boundary Detection in SEM Images of Multilayer Paintings

**Prof. Anna Mikhailova**

*Federal Research Center of Chemical Physics, Russian Academy of Sciences, Russia*

Scanning electron microscopy (SEM) uses an electron beam to scan a sample surface and produce high-resolution images of its microstructure. Such SEM images facilitate the visualization of paint, ground, and varnish layers. Accurately identifying boundaries between these layers accurately is essential for understanding how artworks were created and for planning their restoration. However, different icon layers in SEM images may share similar average

brightness despite having distinct microstructures. Standard edge detectors, such as the Canny filter, only detect brightness gradients. Deep learning methods, by contrast, require large labeled datasets, which are impossible to collect for unique cultural heritage objects. A method for boundary detection that requires no training was developed in this study. It calculates the local standard deviation of brightness in a sliding window, computes the gradient of this map, and applies a threshold to filter out weak transitions. Testing on cross-sections of two icons ("Euphrosyne Full-Length from the Deesis Tier" and "Christ Pantocrator Enthroned") showed that the automated boundaries matched the manual expert annotations. This provides conservators with a reliable basis for selecting sampling points for EDS, Raman, and FTIR analysis and for documenting stratigraphy. The method's limitations include the manual selection of the threshold and window size. However, the approach can be further modified by incorporating additional image features.

**12** INVITED

## Wireless Self-Powered Sensor Systems and Their Applications in Healthcare Monitoring

**Prof. Yannan Xie**

*Nanjing University of Posts and Telecommunications, China*

Recently, wearable sensors have experienced a rapid development and are greatly desirable for commercial, medical, and military applications. Among them, the self-powered sensing technology has been recognized to be a promising sub-category and exhibit vast potential in healthcare and biomedical monitoring, prosthesis development, sport sensing, and human-machine interfacing. The self-powered active sensor will generate electricity as a response to the external stimuli and the electric signal can reversely reflect the impact of the outside trigger. Therefore, it is able to effectively and independently work without any external power sources. Originated from Maxwell's displacement current, triboelectric nanogenerator (TENG) based on a coupling of triboelectric effect and electrostatic induction has been developing rapidly for self-powered active sensor. Here, we report a series of wireless self-powered sensors and their applications in healthcare Monitoring. Firstly, a seesaw structure TENG (SS-TENG) has been proposed based on vertical contact-separation working mode. Thanks to the asymmetric structure, the SS-TENG can be adopted to monitor the motion direction and velocity of moving objects. Being integrated with shoes or insoles, the SS-TENG can detect the foot posture under natural human motion. Secondly, a self-powered breath sensor based on the angle-shaped TENG has been demonstrated to monitoring the pulmonary function of human. Therefore, the above discussed wearable TENGs may provide a new prospect for self-powered active healthcare and biomedical sensors and have potential applications in the fields of healthcare monitoring, human-machine interfacing, and prosthesis developing.

**13** INVITED

## Self-powered and self-healing dielectric elastomer actuators based artificial muscle with triboelectric nanogenerators

**Prof. Dan Yang**

*Beijing University of Chemical Technology, China*

Dielectric elastomer actuators (DEAs) have been intensively studied as a promising candidate for artificial muscle. However, their high voltage requirements and vulnerability to external damage limit their widespread application and long-term service life. To extend the service lifetime of DEAs, reversible covalent bonds, such as disulfide bonds and imine bonds have been constructed in polymer chains to design self-healing DEs. Furthermore, a triboelectric nanogenerator (TENG) with characteristics of a high output voltage and a low current was used to drive the self-healing DEA, resulting in a self-powered and self-healing DEA system (TENG-SDEA), which ensures the safe operation of the DEA and avoids electrical breakdown. Finally, an extraocular-muscle-like actuator with oriented motion ability integrated by several TENG-SDEAs was constructed. Additionally, the SDEA was directly used as a flexible capacitive sensor for real-time monitoring of the patient's motion. The presented SDEA provides guidance not only for the artificial muscles that mimic natural muscles but also for future intelligent integrated devices.

14 INVITED

## 力学超材料结构与振动控制

**Prof. Xin Fang**

*National University of Defense Technology, China*

*Abstract not received at the time of printing.*

15 INVITED

## Biosensing on soft tissues

**Prof. Ting Wang**

*Nanjing University of Posts and Telecommunications, China*

*Abstract not received at the time of printing.*

16 INVITED

## Piezo-phototronic Effects in GaN based Laser Diodes by Extreme Pressure Application with Nanometer Resolution

**Prof. Ding Li**

*Beijing Institute of Nanoenergy and Nanosystems, CAS, China*

Third generation semiconductors such as ZnO, GaN, and SiC exhibit superior physical properties such as a higher band gap, a higher saturation velocity, an increased thermal conductivity, and a high melting point when compared to the previous generations. Due to their hexagonal wurtzite crystallographic structure, they are subjected to the piezoelectric effect and thus exhibit a piezoelectric potential (piezopotential) when exposed to mechanical strain. Here, I would like to report the preliminary experimental results on how a highly localized extreme mechanical stress (~ GPa) influences the optical properties of GaN based laser diodes with different lasing wavelength at different force application area of nanometer resolution. The intensity of laser increases when the pressure is applied to the ridge region covered with metal contact due to the Piezo-phototronic effects. It is a collaboration results between the experts of CAS-BINN and the atomic force microscopy (AFM) and microcantilever experts from Austria. Thanks to the development of a so-called “Nanomechanical Force Applicator” (NFA). This unique experimental setup will allow for the first time to perform groundbreaking experiments on nanometer scale on any location of a device with research interests.

17 INVITED

## Neuromorphic Tactile Sensory Systems for Biomedical Engineering

**Prof. Libo Chen**

*Uppsala University, Sweden*

Neuromorphic tactile sensory systems leverage principles of biological neural computation to enable real-time, adaptive, and energy-efficient processing of complex sensory signals. By integrating advanced sensing technologies with both hardware and software based on spiking neural networks (SNNs), these systems emulate key functions of the human peripheral and central nervous systems. Such architectures offer significant advantages, including ultra–low power consumption, high temporal precision, on-device learning, and robust operation under noisy or dynamic conditions.

Here, we present our recent work in neuromorphic tactile sensory systems for biomedical applications. We have developed a neuromorphic tactile system. By relying on spike timing to encode tactile information, the system achieves millisecond-level temporal precision comparable to the human counterpart. This enables much more rapid and accurate object discrimination across different grasping tasks, compared with conventional electronic skin, and efficiently extracts the dynamics of tactile features during physical interaction. These capabilities make the neuromorphic tactile system a promising foundation for next-generation prosthetics and robotics that require fast,

reliable tactile feedback. The convergence of neuromorphic technologies with biomedical needs opens new pathways for next-generation intelligent health systems.

18 INVITED

## High-performance triboelectric nanogenerators for intelligent sports

**Prof. Jianjun Luo**

*Beijing Institute of Nanoenergy and Nanosystems, CAS, China*

The rapid development of intelligent sports systems has created an urgent need for sustainable and autonomous energy solutions to power distributed sensor networks essential for real-time motion monitoring, performance analysis, and injury prevention. Conventional power sources, such as batteries, are constrained by limited operational lifespan, maintenance requirements, and environmental impacts, particularly in sports applications involving frequent movement and widely distributed sensing nodes. Triboelectric nanogenerators (TENGs) can efficiently convert mechanical energy from sources such as human motion and equipment vibrations into electrical energy, providing an ideal platform for both energy harvesting and sensing in next-generation intelligent sports systems. This report highlights recent advances in the design and material innovation of high-performance triboelectric nanogenerators, as well as self-powered intelligent sports systems developed on this basis. These systems enable real-time biomechanical sensing, motion capture, and data-driven performance feedback without relying on external power supplies, thereby opening new avenues for sustainable smart training technologies.

19 INVITED

## Performance Enhancement Strategies and Application Exploration of Novel Triboelectric Energy Conversion Technology

**Prof. Hengyu Guo**

*Chongqing University, China*

Mechanical-to-electrical conversion technology is fundamental to the development of mechanical energy harvesting and mechanical-quantity sensing devices. In recent years, novel triboelectric energy conversion technology developed based on the contact electrification effect at dielectric material interfaces has become an important research direction in the fields of micro/nano energy and sensing, owing to its many outstanding features—such as simple structure and diverse material options—compared with traditional electromagnetic induction and piezoelectric technologies. Triboelectric conversion devices possess a special capacitive structure, which determines their constitutive characteristics of high voltage, low current, and output saturation. This talk will report our team's recent work on this technology, including new principles and methods proposed through interdisciplinary research approaches for improving device performance. It will also showcase new strategies for self-powered air pollutant abatement and highly sensitive auditory sensing developed based on this technology.

20 INVITED

## Surface/interface charge regulation and energy harvesting devices

**Prof. Zhihao Zhao**

*Beijing Institute of Nanoenergy and Nanosystems, CAS, China*

Developing sustainable and distributed energy-harvesting technologies is essential for powering emerging electronic systems, including the Internet of Things and intelligent sensors. Triboelectric nanogenerators (TENGs) can convert low-frequency mechanical energy from the ambient environment into electricity, with their output performance strongly governed by the generation, transport, and dissipation of surface and interfacial charges. At high charge densities, coupled processes such as electrostatic breakdown, charge migration, and energy dissipation impose significant limitations on device performance and long-term stability. Meanwhile, complex electric double-layer dynamics at liquid–solid interfaces further constrain energy conversion efficiency. This presentation will focus on

material surface and interfacial charge regulation, covering charge-density limit enhancement and stability control at gas–solid interfaces, directional surface charge transport and efficient charge collection, as well as liquid–solid interfacial charge dynamics and high-power-density energy harvesting. Strategies based on electrical property engineering, interfacial electric-field regulation, and device-structure optimization for improving the output performance and practical applicability of TENGs will also be discussed.

**21** INVITED

## High-performance alloys designed via large language models and knowledge graphs

**Prof. Honghui Wu**

*Beijing Institute of Nanoenergy; University of Science and Technology Beijing, China*

Conventional alloy development relies heavily on trial-and-error experimentation, leading to long research cycles and limited prediction accuracy, particularly for material systems with scarce experimental data. We propose a unified data-driven strategy based on large language models (LLMs) and literature knowledge mining, applied to Fe-based alloys. This strategy leverages LLMs to automatically extract structured composition-processing-property data from extensive publications, and integrates domain knowledge enhancement methods including retrieval-augmented generation and knowledge graph representation to mine implicit mechanistic insights and generate physically meaningful augmented descriptors, addressing the information limitation of conventional numerical descriptors. Combined with machine learning and intelligent optimization algorithms, this approach substantially improves the reliability of material property prediction and enables efficient exploration of the alloy design space. Experimental verification shows that the strategy achieves stable performance prediction under data-scarce conditions and accelerates the discovery of high-performance alloys with balanced properties. This work provides a generalizable paradigm for the intelligent development of advanced metallic materials.

**22** INVITED

## Single-Atom/Nanocluster-Mediated Thermo-, Electro-, and Contact-Electrocatalysis for Green Valorization of Industrial Flue Gas toward Value-Added Chemicals

**Prof. Jun Wu**

*Central South University, China*

As a key energy carrier for achieving the "dual carbon" goals, the green production technology of hydrogen and alternative fuels is a focal point of current academic frontiers and industrial competition. The non-ferrous metallurgical industry emits large amounts of complex flue gas containing NO, $H_2S$, $CO_2$, and perfluorocarbons every year which is both a severe environmental burden and a potential resource for hydrogen and alternative fuels. However, due to the complex composition of flue gas, low pollutant concentrations, and the susceptibility of catalysts poisoning and deactivation, traditional catalytic technologies struggle to achieve the synergy of deep pollutant purification and hydrogen extraction. This study combines the advantages of precise structural regulation of single-atom/ocluster catalytic materials with electrocatalysis, thermocatalysis, and the emerging contact-electro-catalysis (CEC), and conducts systematic research around "controllable catalyst—multi-path catalytic conversion—improvement of anti-poisoning performance".

**23** INVITED

## Defect Engineering for Multifunctional Electromagnetic Wave Absorption

**Prof. Song Ma**

*Institute of Metal Research, CAS, China*

The growing demands for electromagnetic stealth and compatibility in complex environments have stimulated the development of high-performance electromagnetic wave (EMW) absorbing materials with integrated functionalities. However, conventional absorbers often suffer from insufficient impedance matching, limited synergy between

dielectric and magnetic losses, and inadequate environmental adaptability. Defect engineering provides an effective strategy to overcome these challenges by tailoring local lattice structures, electronic states, charge distributions, and magnetic ordering. This presentation focuses on defect-mediated electromagnetic loss mechanisms and multifunctional integration. First, rare-earth ion doping and vacancy engineering are employed to regulate the local crystal structures and electromagnetic parameters of hexagonal ferrites, enabling synergistic optimization of dielectric and magnetic losses. Second, heteroatom doping, stacking faults, and heterointerfaces are introduced to manipulate local charge distributions and enhance defect-induced dipolar polarization, interfacial polarization, and charge carrier transport, revealing the synergistic contributions of multiscale defects to electromagnetic energy dissipation. Furthermore, through the rational design of carbon-based composite architectures, controlled metal ion release, and interfacial functionalization, EMW absorption is integrated with corrosion resistance, antibacterial activity, and flame retardancy. Additionally, highly hollow $Fe_3O_4$ architectures are developed to activate the dynamic response of localized spin magnetic moments on both inner and outer surfaces, thereby strengthening natural and exchange resonance losses for efficient low-frequency EMW absorption. Finally, future challenges and opportunities concerning precise defect characterization, quantitative defect–loss relationships, and multifunctional absorbers for extreme environments are discussed. This work provides fundamental insights and design strategies for developing next-generation multifunctional electromagnetic protection materials.

**24** ORAL

## High-efficiency contact-electro-catalysis (CEC) enabled by electrostatic polarization

**Prof. Ziming Wang**

*University of New South Wales, Australia*

Contact-electrification (CE) is a ubiquitous charging phenomenon, and the CE-driven electron transfer process can promote target reactions through a process known as contact-electro-catalysis (CEC). Recent studies have demonstrated that the charged surface after CE could derive a high-intensity electric field in the vicinity (~109 V/m), and such a high-intensity electric field is supposed to polarize adjacent metallic catalysts. Here, we proposed an electrostatic polarization strategy to significantly enhance CEC efficiency and demonstrated its realistic application in hydrogen extraction from seawater. Owing to the ubiquity of CE effect, we envision this paradigm-shift technology opens up exciting possibilities for the development of innovative CEC systems.

**25** ORAL

## Design of a Biomimetic Intelligent Muscle System

**Dr. Wenhui Chen**

*Peking University, China*

Inspired by animals' multisensory integration and redundant musculoskeletal actuation, this study develops a biomimetic neuromuscular system that integrates self-sensing artificial muscles, multimodal perception, and redundant control. A coupled mechanical–thermal–electrical resistance model is established for liquid crystal elastomer (LCE)-based artificial muscles, enabling them to provide both actuation and proprioceptive sensing. Building on this foundation, a soft robotic arm is developed that integrates muscle-length, inertial, and visual information. Reinforcement learning and predictive networks are employed to achieve coordinated control of multiple artificial muscles. Experimental results demonstrate that multimodal feedback improves end-effector positioning and trajectory-tracking accuracy. Actuation redundancy enables stable motion to be maintained even when some artificial muscles fail. Furthermore, when visual information becomes unavailable, predicted visual states, combined with proprioceptive feedback, compensate for the missing information and enable continuous target tracking. The system also integrates a smart headset to map human movements onto robotic motions while providing visual feedback. This work presents an integrated framework for soft robots with state awareness, damage tolerance, and adaptability to complex environments.

26 ORAL

## Phase Stability of Multicomponent Rare-Earth-Doped Zirconia Ceramics

**Dr. Tong Zhang**

*Beijing University of Technology, China*

Yttria-stabilized zirconia (YSZ) containing 6–8 wt% $Y_2O_3$ and predominantly exhibiting a metastable tetragonal (t') structure remains one of the most widely used ceramic materials for thermal barrier coatings (TBCs) because of its low thermal conductivity, favorable high-temperature phase stability, and overall thermophysical performance. The phase stability of zirconia is governed not only by the stabilizer concentration but also by factors such as the size of the dopant cations. To elucidate the effects of the average dopant ionic radius on the thermal stability and lattice structural evolution of the t' phase, a series of multicomponent rare-earth co-doped zirconia solid solutions with different average dopant ionic radius were designed using 8 wt% yttria-stabilized zirconia (8YSZ) as the reference composition. Their phase and structural evolution during heat treatment at different temperatures was systematically investigated. X-ray diffraction (XRD) was employed to characterize the phase constitution and structural evolution, while peak deconvolution of the characteristic reflections in the {400} family was performed to determine the lattice parameters and tetragonality, ($c/\sqrt{2}a$), of the t, t', and c phases.

The results demonstrate that the average dopant ionic radius has a pronounced influence on the high-temperature stability of the t' phase. With increasing average dopant ionic radius, the retained t'-phase fraction after heat treatment decreases, indicating a greater extent of t'-phase decomposition. After heat treatment at 1600 °C, no distinct t' phase can be resolved in the composition with the largest average dopant ionic radius, and only a highly tetragonal t phase together with a near-cubic structural component remains. Further analysis of the lattice parameters reveals that, with increasing extent of t'-phase decomposition, the tetragonality of the t phase progressively increases, whereas that of the residual t' phase continuously decreases toward unity. This evolution indicates that t'-phase decomposition is accompanied by pronounced dopant redistribution: one fraction evolves toward a highly tetragonal, relatively stabilizer-depleted t phase, whereas the other evolves toward a low-tetragonality, near-cubic t''/c-type structure. These results demonstrate that the average dopant ionic radius plays an important role in governing both the high-temperature phase stability and the structural evolution of the t' phase in multicomponent rare-earth-doped zirconia.

# 分论坛二

SYMPOSIUM 02 · INTELLIGENT MANUFACTURING AND PROCESS INNOVATION

智能制造与工艺创新

02

AI EMPOWERMENT · MATERIALS INNOVATION · INTELLIGENT MANUFACTURING

01 KEYNOTE

## A Digital Twin-Driven Ultra-precision Freeform Machining System

**Xichun Luo**

*University of Strathclyde, UK*

Ultra-precision machining technology is at the forefront of manufacturing technologies which enables development of scientific instruments (e.g. particle colliders, gravitational-wave interferometers, space, or ground-based telescopes) for big science discovery and underpins technological advancement in microelectronics, information technology, photonics, and quantum sectors. This talk will firstly discuss evolution of ultra-precision machining system and industrial automation technology for obtaining high-end plano, spherical/aspherical and freeform components. It will then introduce the concept of emerging digital twin (DT) technology in the new era of Industry 4.0. It will also review current research by applying DT for system design, process planning, modelling and optimisation, and quality assurance and maintenance. A case study on development of a predictive DT-driven ultra-precision freeform machining system for dynamic error control will be present for accuracy control in high-frequency slow-tool-servo ultraprecision diamond turning processes. The effectiveness of the DT-driven ultra-precision machining system was demonstrated through machining trials which showed significant improvement in machining accuracy (87%, surface form accuracy; 95%, phase accuracy with precisions of 0.06 μm and 0.05°), and efficiency (8 times the state-of-the-art).

02 KEYNOTE

## Beyond Bulk Properties: Transient Surface Engineering for Augmented Ultraprecision Machining

**Hao Wang**

*National University of Singapore, Singapore*

Ultra-precision machining is conventionally governed by the intrinsic properties of the material being processed. Brittle materials are susceptible to fracture and subsurface damage, while ductile metals can undergo excessive plastic deformation, imposing fundamental limits on achievable precision and surface integrity. But what if the material response could be temporarily re-engineered only where and when machining occurs? This talk introduces transient surface engineering as a new paradigm for augmenting ultra-precision machining. Rather than permanently modifying the bulk material, short-lived physicochemical interactions are used to alter the mechanical response of the near-surface region at the moment of tool–material interaction. Through contrasting studies of copper and $CaF_2$, we demonstrate how the same environmental species can produce fundamentally different machining responses depending on atomic bonding: interactions with water can weaken metallic bonding in copper and reduce cutting resistance, while in ionic $CaF_2$ they lower surface energy and promote fracture. These findings reveal both the opportunity and complexity of manipulating material behaviour through transient surface states. By connecting surface chemistry, atomic bonding and machining mechanics, this work moves beyond treating the machining environment as a passive boundary condition. Instead, it establishes near-surface physicochemical states as an active and dynamically tunable process variable, opening new possibilities for damage-free and high-precision manufacturing of materials that are otherwise difficult to machine.

03 INVITED

## Superhard Materials for High-Speed FSW of Cast Aluminum Alloys and FSW of High-Strength Steels

**Nina Qin (秦景霞)**

*Element Six UK Ltd, UK · 亚洲战略业务总监*

Part of the De Beers Group, Element Six boasts over 80 years of expertise in superhard materials including synthetic diamond and PcBN, with global manufacturing and sales networks. Its premium FSW tools deliver game-changing

performance for industrial friction stir welding. Engineered for cast and extruded aluminium alloys such as ADC12 and 6082, diamond-composite FSW tools feature high hardness, thermal stability and low aluminium adhesion. Validated with TWI, they support welding speeds above 5 m/min and tool life exceeding 10 km, producing defect-free joints for EV battery trays, rail, marine and aerospace components while cutting per-metre welding costs. For steel welding, Element Six PcBN tools handle 1-15 mm-thick carbon steel, advanced high-strength steel and stainless steel even underwater. Powered by proprietary HPHT technology, Element Six provides reliable, cost-effective full-set FSW solutions for mass production.

04 ORAL

## AI-Driven Friction Prediction and Inverse Design of Two-Dimensional Materials for Intelligent Manufacturing

**Shiyi Song (宋时弈)**

*Tsinghua University, China, Ph.D*

Friction and interfacial behavior play a critical role in precision processing, surface engineering, and advanced manufacturing, yet their strong dependence on material structure and operating conditions makes conventional trial-and-error optimization costly and inefficient. Here, we present an artificial-intelligence-driven framework that integrates generative modeling, machine-learning interatomic potentials, and atomistic dynamics for friction prediction and materials design. Using two-dimensional metal–organic frameworks (2D MOFs) as a representative platform, a hierarchical generative model is developed to learn both local chemical building blocks and their periodic assembly, enabling the generation of structurally diverse candidate materials. Machine-learning potentials combined with non-equilibrium molecular dynamics are then used to characterize interfacial sliding under different normal pressures. To further reduce the computational cost of repeated molecular dynamics simulations, a pressure-conditioned trajectory learning model is introduced to predict atomistic sliding dynamics and derive long-term frictional responses from the predicted trajectories. The resulting framework establishes a direct connection between material structure, interfacial dynamics, and frictional properties, and provides a pathway toward the inverse design of materials with targeted frictional performance. More broadly, this work demonstrates how generative AI and physics-informed dynamic surrogate models can support data-driven interface engineering and accelerate the development of intelligent manufacturing processes.

05 INVITED

## An Active-Learning Framework for Machine-Learning Potential Development in Mechanochemical Coupling Systems: A Case Study of Co CMP

**Yating Huang (黄雅婷)**

*Beijing Technology and Business University, China*

Deep learning potentials fit interatomic interactions with neural networks, combining DFT-level accuracy with the efficiency of large-scale simulation, and are well suited to mechanochemical coupling systems such as chemical mechanical polishing (CMP). However, their training relies on high-quality data. In this work, we construct a double-loop training workflow. In the first loop, a ReaxFF force field for the $SiO_2$–slurry–Co multiphase system is trained and iteratively optimized on a DFT-labeled dataset. In the second loop, trajectories generated by this force field under diverse configurations and temperatures are used to train a DeepMD potential, with the energy RMSE converging below 0.008 eV. The trained potential is then examined in MD simulations; configurations exhibiting unreasonable molecular behavior are perturbed to generate new samples for iterative retraining, forming an active learning closed loop. In simulations of a reactive system with nearly ten thousand atoms, the GPU-accelerated compressed DeepMD potential achieves a throughput 5.5 times higher than ReaxFF, with 37 times lower memory consumption, and the advantage grows further with system size. This double-loop workflow enables the construction of high-precision deep

learning potentials for CMP and related mechanochemical coupling systems, supporting atomistically accurate simulation and polishing process optimization.

06 INVITED

## Key Technologies of Augmented Reality-Assisted Assembly Guidance and Inspection

**Jianfu Zhang (张建富)**

*Tsinghua University, China*

Augmented reality (AR)-assisted assembly refers to the technology of integrating virtual assembly information with the real assembly environment, using AR systems to assist operators in assembly and inspection tasks. This technology can improve the accuracy, immediacy, and efficiency of assembly information presentation, thereby enhancing manual assembly and inspection efficiency, reducing assembly error rates and learning difficulty, and improving product assembly quality. Targeting the demands of complex final assembly scenarios for aerospace products, such as instrument assembly inside cabins, cable and pipeline routing, assembly feature recognition, and assembly consistency verification, this report focuses on key technologies of AR-aided assembly, including registration methods for large-scale assembly scenes, cross-view path estimation for deformable linear objects, multi-view joint pose estimation of rigid objects, and rapid generation of AR-aided assembly instructions, as well as their application status.

06 INVITED

## 具身智能机器人助力农业现代化

**Zihua Zhang (张子华)**

*Beijing University of Technology, China · 机设系主任/副教授*

面向农业现代化发展需求，团队围绕具身智能机器人赋能设施农业开展研究。农艺标准化是全程农机作业的基础，通过水肥管路、种植架、定植槽标准化搭建，为机械化、规模化作业提供前提。项目组研发了系列智能农机装备，覆盖叶菜、果蔬、花卉与中草药，实现播种、移栽、定植、收获全流程作业，并在多地现代农业产业园开展落地应用。研究融合人工智能、数字孪生技术，构建“云-边-端”协同智能环控系统，采集环境与植物生理表型数据，搭建生长-环控预测模型，实现温室环境智能调控与作物生长精准管理。针对设施采摘，研发具身农业机器人，依托三维表型重构、VLA 大模型与视觉伺服，将传统扫描采摘升级为“感知-预测-决策-逼近式抓取”自主作业模式，同时实现多机协同转运。以挤奶机器人为案例探索 AI 辅助复杂装备设计方法，结合数字孪生与 AI 异常行为推理，挖掘作业断点，迭代优化装备方案。整套研究构建设施农业“感知-预测-决策-执行”全自主闭环体系，为智慧农业装备研发提供技术参考。

07 INVITED

## 基于动态三维场景表征的机器人导航与操作

**Shufei Li (李树飞)**

*Tianjin University, China*

面向复杂动态环境下机器人自主导航与精细作业需求，本报告围绕动态三维场景表征驱动的机器人导航与操作方法展开。通过构建动态三维体素地图与场景图相结合的环境表征方法，实现物体状态与空间关系的持续更新和长期记忆；进一步结合视觉语言模型感知与大语言模型推理，完成动态场景图辅助的任务规划、导航与移动操作，并融合时间新颖性与语义相似度驱动主动探索机制，实现未知环境下目标自主搜索与感知记忆更新，为复杂非结构化场景中机器人长期自主作业提供基础。

08 KEYNOTE

## Wood Nanofiber Assembly for Sustainable Water Management

**Wenshuai Chen (陈文帅)**

*Northeast Forestry University, China*

Against the backdrop of the carbon neutrality strategy, the high-value development and utilization of low-grade forest waste has become a hot topic in the field of forestry engineering. Wood fibrils can be extracted by deconstructing wood cell walls and are the most abundant biopolymer nanofibers in nature. With their sustainability and unique structure, they have attracted considerable attention in the field of sustainable materials in recent years. This presentation first describes the multiscale composite structure of forest resources; then introduces the fibrillation techniques and nanostructural characteristics of wood fibrils, as well as how to use wood fibrils as building blocks to develop functional gels; and finally presents the application explorations of wood fibril gels in wastewater purification, atmospheric water harvesting, and dehumidification.

09 KEYNOTE

## 高端装备制造业离散车间梯度化智能制造系统构建模式与实施路线 —以轨道交通装备行业为例

**Zengqiang Jiang (蒋增强)**

*Beijing Jiaotong University, China*

轨道交通装备制造业作为典型的高端装备离散制造行业，各产品板块在附加值、生产批量、标准化程度和数字化基础上差异显著，企业在 "智改数转" 深化阶段普遍面临 "一步到位难落地、零散试点难成体系" 的困境，缺乏可对号入座、梯次推进的实施路径。本研究依托团队在轨道交通、航空航天、汽车等离散制造领域五十余个柔性智能装备落地实践，以国家智能制造能力成熟度模型和典型场景参考指引为依据，融合产品 - 工艺矩阵与产线核心能力体系，提出梯度化智能制造构建方法：按板块生产与竞争特性，将产线划分为高值标准化、定制柔性化、经济批量型、高值连续型四类梯度，逐档提炼核心能力与典型场景用例，形成可复用的场景用例库，并按 "规划 — 规范 — 集成 — 优化 — 引领" 成熟度阶段给出差异化实施路线。该成果为轨道交通装备及同类离散制造企业提供了分梯度、配场景、按阶段的可复制建设指南，避免盲目攀高与重复建设，推动智能制造从单点示范走向规模化、高质量发展。

10 INVITED

## Origami-Inspired Triboelectric Nanogenerators for Simultaneous Energy and Information Harvesting

**Guobiao Hu (胡国标)**

*The Hong Kong University of Science and Technology (Guangzhou), China*

Battery-free sensing systems have attracted increasing attention in recent years, especially in the context of the Internet of Things (IoT) and smart wearable technologies. However, in practice, it remains challenging to obtain sufficient and stable energy from ambient mechani-cal inputs, while at the same time enabling reliable sensing and communication. Another as-pect that is often overlooked is that the electrical output generated from mechanical motion inherently contains information about the excitation itself. In this study, we propose and pre-sent an origami-inspired system that aims to address these challenges in an integrated manner. By leveraging an origami-based folding architecture, the structure can transform simple me-chanical inputs into enhanced electrical responses through geometric reconfiguration and in-creased effective contact area. This provides a practical approach to improving energy har-vesting performance without significantly increasing system size or complexity. To further enhance practical operation, a dedicated energy regulation strategy is utilized to manage the intermittent output and improve compatibility with low-power electronics. This allows the system to directly power simple electronic components and support event-driven operation under minimal mechanical excitation. In addition, the generated electrical signals encode the characteristics of the triggering motion. This makes it possible to utilize the same physical process for

motion information extraction. By integrating the system with wireless communi-cation modules, we demonstrate that a gentle hand-tap can simultaneously enable sensing and data transmission. Overall, this work highlights a system-level perspective in which energy harvesting and information extraction are realized together and provides a feasible pathway toward the development of scalable battery-free systems for human-machine interaction and distributed sensing.

**11** INVITED

## 尾流诱导振动型摩擦纳米发电机用于低流速水流能量采集与自供能感知

**Junlei Wang (王军雷)**

*Zhengzhou University, China*

针对传统发电装置在低流速（<0.5 m/s）水流环境中适应性不足、启动流速较高及河流生态监测中分布式传感节点的自供能需求，提出一种尾流诱导振动型摩擦纳米发电机（Wake induced vibration based-TENG 简称 WTENG）。通过引入上游诱导钝体，利用周期性旋涡脱落形成的非定常尾流激励下游钝体摆动，增大下游钝体振动幅值及摩擦电单元的接触频率，从而增强摩擦电输出。结构优化与性能测试表明，该装置具有良好的低流速环境适应性，起振流速低至 0.15 m/s，在 0.4 m/s 来流速度下峰值体积功率密度达到 18.26 W/m³。进一步设计集成式能量管理电路，使 47 μF 电容的充电速率提高至原来的 6.13 倍。利用采集的水流能量，成功驱动无线温度传感器，在无需外部电源输入的条件下，实现环境温度数据向移动终端的无线传输。本研究为低流速水流能量采集及河流生态监测自供能传感系统的开发提供了一种具有实用性和可扩展性的技术方案。

**12** INVITED

## Integrated Optimization of Full-Process Processing Parameters Based on Artificial Intelligence

**Wenjing Wang (王文静)**

*University of Science and Technology Beijing, China*

To address the strong nonlinear coupling among multi-objective performance indicators in the full-process fabrication and processing of materials, a multi-objective optimization strategy is implemented based on the decoupling concept. The strongly nonlinear coupling relationships between processing parameters of each stage and among different procedures are embedded into an appropriate high-dimensional feature space. Combined with neural network models, a data-driven mapping model of material **processing–microstructure–property** is established. A hybrid model with high computational efficiency and prediction accuracy is constructed, and an intelligent integrated optimization method for full-process processing parameters with multiple material design objectives is developed. This method enables stable industrial fabrication technology for high-performance materials and guarantees the reliable supply of critical materials for high-end equipment.

**13** INVITED

## Title to be announced

**Sergi Dosta**

*University of Barcelona, Spain*

*Abstract not received at the time of printing.*

**14** KEYNOTE

## 生成式 AI 赋能自主化学实验：具身智能化学机器人关键技术

**Zhengcai Cao (曹政才)**

*Harbin Institute of Technology, China*

化学实验反应路径复杂、实验条件严苛、操作精度要求高，现有人工操作存在方案设计低效、重复步骤耗时长、安全隐患率高的瓶颈。为此，研制一款生成式 AI 驱动的具身智能化学实验机器人，融合大语言模型与图扩散自主生成

反应路径与实验方案；基于视觉语言大模型实时理解实验场景并监测反应进程；采用奖赏塑型模仿学习和迁移学习拟人化复现实验操作。旨在实现“方案设计、任务规划、反应监测、技能学习”全流程自主化，推动化学实验研究由“人工经验驱动”向“数据与知识驱动”的智能科研新范式转变。

15 KEYNOTE

## 多品种变批量产品智能制造数字孪生车间关键技术及应用

**Ying Cheng (程颖)**

*Beihang University, China*

空天装备、新能源汽车、3C 等典型柔性制造行业，均采用多品种变批量共线生产模式，存在高频次换产、高质量要求等挑战，如何在既有资源和约束下开展高质高效生产，是其共性难题。传统换产配置物理调试、工艺经验调参、异常事后容错方法，无法满足上述需求，数字孪生提供了有效途径。北航 makeTwin 团队提出了数字孪生车间概念，创建了数字孪生车间理论-技术-工具-标准体系，成果应用于卫星、新能源汽车、智能手机等行业智造，为推动车间生产管控由经验式向数智化转型升级提供理论与实践参考。

16 INVITED

## Flexure-based dynamic vibration absorbers: Design theory and applications in machining chatter control

**Wenshuo Ma (马文硕)**

*Beihang University, China*

动力吸振是解决高速机械装备颤振问题的有效手段之一。柔性单元既构成动力吸振器的弹性元件，又是实现振动能量高效传递的关键介质，直接决定其抑振性能。现有动力吸振器结构相对复杂或主振结构建模精度欠佳，结构设计严重依赖经验，尚缺乏确定性与普适性的设计理论方法，进而阻碍技术发展及应用。针对上述不足，本研究从柔性机构学的视角，围绕动力吸振的作用机理、设计理论及工程应用开展深入研究。旨在为多种类型吸振器的构型、参数与结构设计及性能优化提供理论方法与通用性框架，结果不仅对实现最优抑振性能的动力吸振器设计具有指导意义，同时对形成动力吸振核心技术具有重要价值。研究可为面向薄壁零件、弱刚性刀具等引发的加工颤振难题的抑振装置设计提供指导，在航空航天、精密光学仪器等领域中具有广阔应用前景。

17 ORAL

## Improvement of creep resistance in Ni-based superalloys via compact γ′/γ″ co-precipitation design

**Shengyu Zhou (周生玉)**

*Tianjin University, China*

*Abstract not received at the time of printing.*

18 KEYNOTE

## 硬脆材料复杂曲面器件超精密加工技术

**Wule Zhu (朱吴乐)**

*Zhejiang University, China*

硬脆材料复杂器件是航空航天等重大装备的核心构件，柔性超精密加工是实现高精度与高性能的有效手段，报告将从工具、流体、工件以及完整性调控等多个层面介绍如何解决柔性加工难控、效率低、精度难以提升等问题，实现针对硬脆材料复杂器件超光滑、高完整性精度的柔性超精密制造。

19 INVITED

## Exploring Tellurium-Based Semiconductor Nanostructures for Emerging Electronics

**Johnny Ho (何颂贤)**

*City University of Hong Kong, Hong Kong SAR, China*

*Abstract not received at the time of printing.*

20 KEYNOTE

## AI-Driven digitization of dynamic hand motion into soft matter

**Jinhye Bae**

*Chung-Ang University, Republic of Korea; UC San Diego, USA*

Digitizing the sophisticated, time-resolved motions of the human hand into untethered soft robots has remained a formidable challenge owing to limited spatiotemporal control in active materials and a persistent reliance on empirical design. In this talk, I will introduce a new soft actuation paradigm integrated with an AI-driven dynamic motion-targeting inverse design framework that directly digitizes video-recorded human hand motions into 4D-printable architectures. By discretizing active chambers within passive matrices, we achieve programmable and accurate control over both the magnitude and the kinetics of local bending—capabilities unattainable with previous inverse design approaches that targeted only static equilibrium states. Using a long short-term memory deep-learning model trained on finite-element simulations, we obtain high-fidelity forward predictions of deformation trajectories at speeds four orders of magnitude faster than conventional numerical simulations. These results demonstrate how machine intelligence can encode real biological dynamics directly into material architectures, establishing a “video-to-matter” digitization route. This platform is poised to transform adaptive prosthetics, autonomous manipulation and lifelike bioinspired robotics.

21 INVITED

## Engineering cellulose materials for triboelectric energy harvesting

**Renyun Zhang**

*Mid Sweden University, Sweden*

Cellulose-based triboelectric nanogenerators (TENGs) have garnered significant attention for their eco-friendly, flexible, and cost-effective potential in energy harvesting. Among the latest developments, the engineering of triboelectric paper stands out as a groundbreaking strategy to bridge sustainable materials with advanced functionality. In particular, our recent study has demonstrated a scalable fabrication method where common paper is chemically and physically modified to significantly enhance surface charge density, durability, and responsiveness. This engineered paper achieves robust power output while maintaining mechanical flexibility, making it ideal for wearable electronics and smart environmental sensing.Complementary studies have further elevated cellulose's role in TENGs. Fully green systems exhibit power densities exceeding 300 $W\,m^{-2}$, while regenerated cellulose films, tailored via solvent treatments, display optimized charge characteristics and adaptability to different counter-tribolayers. Additionally, upcycled wastepaper and hetero-triboelectric structures based on plant skins offer sustainable routes to high-performance nanogenerators. Collectively, these innovations showcase the transition from fundamental material science to applied engineering, where cellulose not only supports the green energy agenda but also paves the way for multifunctional, integrated energy-sensing platforms. This presentation highlights the synergy of material tailoring and structural engineering in shaping the future of triboelectric energy systems.

22 INVITED

## 3D Printing of Conformal Electronic Systems

**Jin Huang (黄进)**

*Xidian University, China*

The conformal electronic system is not only conformal with its carrier, such as aircraft and high-speed train, but also combines structural bearing, heat dispersion, electromagnetic radiation to one structural component, in which the structure parts and the electromagnetic parts are closely integrated. Thus traditional electro-mechanical dissociated manufacturing methods can hardly to be effective. Integrated printing method, i.e. printing and sintering the structure, heat sink, microwave circuit and radiating element synchronously, is one of the most promising technologies for its fabrication. This talk presents a novel 3D printing technique for fabricating conformal electronic system. Firstly, a five-axis ink-jet printing system is proposed for fabricating a conductive pattern on undevelopable surface. Secondly, an equivalent circuit model for piezoelectric print-head (PPH) is built for analyse the printing process. Based on that, an adaptive printing control is put forwarded, with the pressure wave self-sensing technique of a PPH, to improve printing accuracy and expand the applicability of materials. Finally, photon sintering with power control is proposed to improve the electrical conductivity of conductive patterns. Experimental results show the effectiveness of those proposed methods.

23 INVITED

## 各向异性二维材料的可控制备和光电器件

**Hua Xu（徐华）**

*Shaanxi Normal University, China*

二维原子晶体材料丰富的结构和优异的性质使其在构筑下一代纳电子器件方面具有广阔的应用前景。本报告将介绍最近几年我们课题组在各向异性二维材料的可控制备和光电器件应用方面的研究进展：（1）发展了角分辨偏振拉曼光谱和角分辨偏振光学成像技术，揭示了各向异性二维铼基过渡金属硫族化合物独特的“纳米组装生长”模式；（2）发展了低共熔体辅助生长、空间限域外延、基底晶格诱导外延和基底纳米沟槽诱导外延等材料创制新方法，实现了大面积、高质量、取向均一各向异性二维材料的可控制备；（3）提出了组分和相结构协同调控二维材料性质策略，实现了其能带结构和导电属性的连续调制；（4）基于二维材料表界面势场调控器件性能理念，成功构筑了高灵敏度、宽光谱和偏振敏感光电探测器等新型光电功能器件。以上研究促进了二维材料基础研究和光电器件应用的发展。

24 INVITED

## Design and Construction of Flexible Optoelectronic Devices for Healthcare Monitoring and Therapy

**Peng Li (李鹏)**

*Northwestern Polytechnical University, China*

Flexible electronics offer lightweight, mechanically compliant platforms that conform to the human body, enabling comfortable wearable and minimally invasive implantable devices for personalized healthcare. Integrating these platforms with optical sensing and light-based therapy creates opportunities for localized physiological monitoring and precise therapeutic intervention. Here, we present the design and construction of wearable and implantable optoelectronic devices that combine therapeutic light delivery with physiological monitoring. First, flexible wearable light sources based on electroluminescence were developed for photodynamic therapy (PDT). These conformable devices effectively eliminate drug-resistant bacteria and accelerate chronic wound healing, improving comfort and enabling treatment beyond conventional clinical settings. Second, a wireless, minimally invasive biophotonic system was designed for deep-tissue PDT. Powered by an adjustable electromagnetic field, the system provides controllable illumination to generate reactive oxygen species, achieving over 99% antibacterial activity and more than 90% inhibition of osteosarcoma cell growth. By delivering light directly to target tissues, it addresses the limited penetration

of externally applied illumination. Third, a flexible implantable platform integrating oxygen saturation ($sO_2$) sensing, Bluetooth communication, wireless power, and microscale light-emitting diodes (μ-LEDs) was developed to couple local monitoring with in situ therapy. The platform enables the identification of microtumors through monitoring of hypoxic environments and tracks oxygen consumption during treatment, providing real-time feedback on the therapeutic process. Together, these advances establish a versatile optoelectronic platform spanning wearable treatment, deep-tissue intervention, and integrated sensing–therapy, supporting the development of personalized healthcare for both superficial and internal diseases.

**25** INVITED

## New materials for 2D, 3D and 4D printing

**Shlomo Magdassi**

*The Hebrew University of Jerusalem, Israel*

Additive manufacturing continues to transform industries ranging from aerospace and electronics to medicine and soft robotics. However, a key bottleneck remains: the limited availability of materials with tailored, multi-functional properties. This presentation highlights recent advances in the design of organic, ceramic, and hybrid materials tailored for 2D, 3D, and emerging 4D printing technologies. Particular focus is given to integrating nanoparticles, nanocomposites, and plasmonic colloids to unlock new functionalities and innovative printing concepts. Representative examples include conductive nanomaterials for flexible electronics, stretchable nanocomposites for soft robotics, printed solar cells, wood-derived and recyclable polymer matrices, water-dispersible eco-friendly inks, and self-healing systems. Additionally, the strategic use of plasmonic light-matter interactions in metallic nanoparticles is presented to demonstrate nanoscale spatial control during stereolithography, by photoconversion process. Together, these developments, along with our efforts to design next-generation sustainable and recyclable printing materials, illustrate how advanced material innovations are driving the transition toward functional, adaptive, and eco-friendly additive manufacturing.

**26** ORAL

## Temperature Field Analysis and Thermal Effects on the Dynamic Characteristics of Constant-Flow Closed Hydrostatic Turntables

**Jianqiao Bao（鲍建桥）**

*Beijing University of Technology, China*

*Abstract not received at the time of printing.*

# 分论坛三

SYMPOSIUM 03 · INTELLIGENT SENSING AND NEW-GENERATION AI

智能传感与新一代人工智能

03

AI EMPOWERMENT · MATERIALS INNOVATION · INTELLIGENT MANUFACTURING

01 INVITED

## A New Silk Road towards Smart Wearables

通向未来智能穿戴的丝绸之路

**张莹莹**

*清华大学 · 教授*

As a natural protein material with over five thousand years of history, silkworm silk is not only widely used in traditional textiles but also occupies an important position in the field of functional materials. China's abundant natural silk resources provide unique advantages for its in-depth research and development, making it a highly promising flexible wearable functional material. In recent years, silk fibers have attracted considerable attention due to their potential applications in sensing, actuation, energy, and other fields. Exploring high-performance and scalable application pathways for silk fibers is of great significance. A thorough investigation into the structure, preparation, and functionalization of silk fibers serves as an essential foundation for unlocking their application potential. In this talk, I will introduce the unique structure and properties of silk materials, and based on research examples, illustrate how innovative methods such as regeneration or compositing can endow silk with new mechanical, electrical, and optical properties. Meanwhile, we will discuss the application potential of these novel silk fiber materials in intelligent wearable devices, biomedical monitoring, sustainable development, and other fields, aiming to provide valuable references for the study of natural fiber materials.

02 INVITED

## Bioinspired Nanoconfined Iontronics

仿生纳米限域离子电子学

**魏迪**

*中国科学院北京纳米能源与系统研究所 · 研究员*

Controlled charge flow is fundamental to many areas of science and technology, serving as charge carriers of energy and information, and probes of material properties and reaction kinetics. In nanoscale systems, particularly those with confinement below 2 nm, classical continuum theories, such as the Navier–Stokes, Kelvin, and Hertz–Knudsen equations, begin to fail, and a range of non-classical ionic phenomena emerge, including electrical double layer (EDL) overlap, ionic Coulomb blockade, and ultra-low resistance ion transport.

Nanoconfined iontronics, which harnesses ions as charge carriers, offers a promising platform to manipulate charge flux, enabling tunable directionality and magnitude of ionic currents in ways reminiscent of biological neural signaling. In this talk, Wei will present recent advances from his group in the design and understanding of nanoconfined iontronic systems, highlighting their potential in energy, information, and interfacial chemical reaction kinetics.

03 INVITED

## Micro- and Nanostructure Engineering of Metallic Glasses for Intelligent Sensing Applications

非晶合金微纳结构构筑与智能传感应用

**兰司**

*南京理工大学 · 教授*

Metallic glasses lack long-range periodicity, yet their apparent disorder conceals distinct short- and medium-range order. This hidden order is decoded as identifiable structural motifs that can be linked to properties and used to guide micro- and nanostructure design. Characteristic nanocluster motifs have been resolved by combining neutron and synchrotron total scattering, atomic-resolution imaging and computational simulations, including the six-membered tricapped trigonal prism ring that bridges the amorphous and crystalline states in Pd–Ni–P alloys and the four-membered Frank–Kasper cluster ring in Cu–Zr–Al–Y bulk metallic glasses. These motifs serve as tunable design units.

Changes in their connectivity and spatial organization are linked to plastic deformation and magnetic nanodomain evolution, providing a structural basis for understanding mechanical and magnetic responses. This understanding guides the coupling of atomic-order regulation with functional micro- and nanostructures, translating local structural changes into measurable sensing responses. Tuning medium-range order and magnetic anisotropy enhances magnetoelastic response and stress-impedance sensing, while atomic-order-guided nanoporous structures and cluster-inspired lattice electrodes combine active reaction interfaces with mechanical stability for sensitive and stable nonenzymatic glucose sensing. Local coordination and reaction-interface engineering further extend this structural design approach to electrocatalytic water splitting. These results show how the order hidden within disorder can be decoded, tuned and translated into functional architectures, offering a motif-guided route to metallic glasses for sensing and energy conversion.

**04** INVITED

## From Lead-Free Ceramics to Fully Organic Systems: Electromechanical Coupling in Hybrid Nanogenerators for Self-Powered Sensing

从无铅陶瓷到全有机体系:面向自供电传感的混合纳米发电机中的机电耦合

**Naratip Vittayakorn**

*泰国先皇理工大学(KMITL) · 教授*

The rapid expansion of IoT and wearable electronics—growing at ~22% annually toward tens of billions of units—demands sustainable, flexible power sources beyond conventional batteries, which suffer from limited lifespan, maintenance burden, and hazardous waste. Harnessing electromechanical coupling, nanogenerators convert human motion and ambient vibration into electricity, yet individual piezoelectric (PENG) and triboelectric (TENG) mechanisms are each limited in either current or voltage. This work presents a synergistic hybrid strategy spanning lead-free inorganic ceramics through to fully organic, biodegradable systems for self-powered sensing. Lead-free BaTiO3 was engineered across morphologies—nanoparticles and salt-flux-derived nanowires and nanorods—and integrated into PDMS or biopolymer matrices with conductive (Ag, carbon nanotube) and dielectric 2D fillers. Bio-based devices employed chitosan–protein composites and pure γ-glycine fillers, combined with soft bacterial-cellulose electrodes and self-charge-pumping (SCP) circuits. Coupling the tribo-negative PDMS matrix with ferroelectric BaTiO3 dipoles yielded 60× voltage and 32× current enhancements (~320 $\mu W/cm^2$), confirming constructive PENG–TENG superposition. In chitosan/$BaTiO_3$-nanorod TENGs, tetragonal ferroelectric polarization elevated surface charge density, while a soft electrode minimized the air gap and an SCP module recirculated charge, raising output to ~247 V and 1568 $\mu W/cm^2$. In organic systems, glycine-rich domains broke centrosymmetry to generate polar moments; at the 50 wt% percolation threshold, an interconnected γ-glycine network maximized stress transfer and interfacial polarization, delivering ~79 V while retaining biodegradability. Integrating synergistic PENG–TENG coupling, nano-architecture engineering, and biodegradable-materials design enables high-performance yet sustainable self-powered devices for wearable sensing and green IoT.

**05** INVITED

## Artificial Intelligence-empowered Signal Processing and Sensing Technologies

人工智能赋能的信号处理与传感技术

**Azamat Yeshmukhametov**

*纳扎尔巴耶夫大学ARMS 实验室负责人*

The rapid development of artificial intelligence (AI) over the past decade has revolutionized the way signals are processed and interpreted, which differs fundamentally from conventional signal processing methods relying on handcrafted features and model-based algorithms with limited adaptability to complex, noisy, and high-dimensional data. Therefore, AI techniques are well worth studying as a driving force for developing novel signal processing and sensing technologies. A new research direction "AI-empowered intelligent sensing" has been proposed. It is suggested

that we can learn from machine learning and deep learning paradigms, e.g., neural network-based feature extraction, end-to-end learning and other AI strategies, to design and develop novel architectures for intelligent signal analysis and perception. In this talk, I will report the recent research work and results about deep learning-inspired, reinforcement learning-inspired and other AI-empowered methods for signal denoising, classification, anomaly detection and multimodal sensor fusion, and evaluate new ideas and directions that need to be emphasized in the future. The AI-empowered approach is promising to produce intelligent sensing systems with enhanced accuracy, robustness and adaptability, especially under complex and dynamically changing real-world conditions.

06 INVITED

## Olfaction Platform based on MEMS Gas Sensor Array

基于 MEMS 气体传感器阵列的人工嗅觉平台及应用

**孙旭辉**

*苏州大学纳米学院 · 教授*

In recent years, artificial olfaction (also named e-nose) based on MEMS gas sensor array and artificial intelligence (AI) algorithms has been developed and widely applied in various areas such as environmental air monitoring, public safety, healthcare, food safety, etc. As the core component of artificial olfaction, gas sensors that detect the types and concentrations of gases in the environment should be meet the essential requirements of small size, low power consumption, high sensitivity and broad-spectrum in various gases. With the development of MEMS technology and artificial intelligence (AI) technology, integration of MEMS gas sensor arrays (analogous to olfactory receptors in biological olfaction) and AI algorithms (analogous to the olfactory nervous system in biological olfaction) make it possible in construction of artificial olfaction platform, achieving the development path of gas sensors from "functional implementation" to "performance improvement" to "intelligent recognition." This talk firstly introduces the development of MEMS gas sensor technology, including synthesis of high-sensitivity sensing materials and fabrication of MEMS hotplates with low-power consumption. Then, integration of artificial olfaction platform based on gas sensor arrays and stable, reliable signal acquisition system is well presented. Based on the data collection and pattern recognition algorithm establishment from different gas scenarios, the practical applications in various fields such as industrial safety, smart home appliances, environment monitoring, quality control, clinic diagnosis, etc. are well briefed.

06 INVITED

## Mechano-iontronic effects for smart sensing applications

机械离电效应及智能传感应用

**蒲雄**

*中国科学院北京纳米能源与系统研究所 · 研究员*

Iontronics couple the electron/ion charge transfers and exchange signals at the interfaces of electronic/ionic conductors, differentiating them from most electronics using electrons and/or holes as the dominating charge carriers. The concept of iontronics has just been proposed in last decade, despite the fact that the co-transfers of ions and electrons have long been employed in many devices, such as electrochemical energy devices, electrical-double-layer field-effect transistors and resistance random-access memories. Soft iontronics expand the toolbox of bio-integrated or bio-interfaced devices, owing to their natural resemblance with living systems; however, the development for analogous integrated ionic systems is immature due to the difficulty of fabricating fundamental circuit devices. We report here a series of iontronics materials and devices based on mechano-ionronic effects, including the tribo-iontronic effect, piezo-ionronic effect and flexo-ionronic effect. The mechanisms of these effects are studied systematically, and the materials are developed with amplified mechano-ionronic effects. Then, we achieve different mechano-ionronic devices for human-interfaced or bio-interfaced applications, especially the mechano-ionronic sensors for tactile, and precontact sensing applications. Our findings provide fundamental and practical insights for developing next-generation advanced sensing technologies.

07 INVITED

## Smart Healthcare Carpet for Parkinson's Disease Gait Monitoring in Natural Scenarios

自然场景下帕金森病步态监测智慧医疗地毯

**吴昊**

*华南理工大学 · 教授*

Parkinson's disease (PD) is the second most common neurodegenerative disease globally. It has an underdiagnosis rate of 60%-70% in early phases owing to insidious motor impairments. Typical PD motor symptoms such as resting tremor, rigidity and bradykinesia impair locomotor synergy, and most pathological alterations manifest as gait abnormalities. Traditional diagnosis depends on expert clinical evaluation and expensive auxiliary examinations, which are not suitable for widespread community screening. In this work, we develop an unobtrusive smart healthcare carpet based on interfacial electromechanical conversion. Relying on interfacial contact electrification and electrostatic induction, the device acquires gait information from natural walking to achieve rapid and accurate screening for Parkinson's disease. The porous topological layer modulates contact-separation between polyethylene film and conductive fibers for stable self-powered voltage signal generation. Machine learning is utilized to process gait signals for disease discrimination. Clinical gait data are collected from 20 PD patients and 20 healthy participants under a standardized 3-m walking-and-turning protocol. The system attains 90% trial-level classification accuracy on subject-independent test set. The carpet maintains ~99% of its initial voltage output after 90-day durability evaluation. This low-cost platform exhibits great potential for unobtrusive early PD screening and longitudinal motor assessment in home and clinical environments. This report will present the design, performance characterization and clinical validation of this smart sensing platform.

08 INVITED

## Charge to Spin Conversion: Materials and Devices

电荷—自旋流转换材料及器件

**徐晓光**

*北京科技大学 · 教授*

Data storage and processing are eternal topics in human development. In the era of big data, the Internet, big data, and artificial intelligence are deeply integrated, leading our life towards digitalization, networking, and intelligence. So, what's the future? Spintronics focuses on both charge and spin of electron at the same time. New physics and phenomena accelerate the developments of information storage and processing. SOT-MRAM is regarded as a promising solution for data storage and processing basing on spin-orbit torque (SOT) driven by charge current, which is featured by non-volatile, high efficiency, high stability and low energy consumption. High-efficient spin moment manipulation via SOT depends on charge to spin conversion materials and devices. In this talk, I will report our recent research work about charge to spin conversion materials and devices, as well as the related physical mechanism.

09 INVITED

## In-situ Energy Harvesting and Self-powered Sensing for Intelligent Operation and Maintenance of Marine and Offshore Equipment

面向船海装备智能运维的原位能量捕获及自驱动感知

**杜太利**

*大连海事大学 · 教授*

Intelligent operation and maintenance of marine and offshore equipment require reliable sensing and sustainable power supply across distributed monitoring networks. Conventional power and sensing solutions face challenges in deployment, durability, and maintenance under complex marine conditions. In-situ energy harvesting and self-powered sensing offer an integrated route to energy autonomy and condition awareness by utilizing mechanical

energy available within equipment. It presents recent advances in triboelectric technologies for marine and offshore applications, outlining a research framework from energy harvesting, autonomous sensing, and intelligent maintenance. The discussion highlights how in-situ energy harvesting and self-powered sensing information can support equipment condition monitoring, fault diagnosis, and intelligent maintenance. These findings provide a physical and methodological basis for coordinating energy supply, condition awareness, and intelligent interaction, advancing distributed sensing and maintenance systems in marine and offshore applications.

**10** INVITED

## Carbon nanotube-based high-performance bioelectronics

碳基高性能生物电子

**胡又凡**

*北京大学 长聘教授*

In situ amplification is crucial for detecting weak physiological signals. We developed carbon nanotube differential amplifiers with 27 dB voltage gain, >43 dB common-mode rejection ratio, and >22 kHz gain-bandwidth product, enabling in situ ECG amplification. Dual-gate electrical and mechanical co-design on ultrathin PI (~125 nm) provided efficient gate control and mechanical stability, yielding TFTs with 8.96 mS/μm transconductance, 127 $cm^2/V{\cdot}s$ mobility, and 84 mV/dec subthreshold swing. These TFTs enabled a differential amplifier with a 1.83 MHz gain-bandwidth product for broadband, high-gain in situ EMG amplification. Furthermore, complementary carbon nanotube TFTs exhibited large-window, gate-modulated negative differential resistance-induced current super-saturation, enabling ultrahigh, exponentially tunable intrinsic gain robust against scaling. Near the singularity point, intrinsic gain varied from $10^2$ to $10^6$. This behavior enabled an operational amplifier with tunable single-stage gain of 35–60 dB and a zero-VGS amplifier with gain above 100 dB for EEG amplification.

**11** INVITED

## Flexible/wearable sensors and systems

柔性可穿戴传感器件及系统

**衣芳**

*中山大学 · 教授*

Wearable technology is changing our life and shaping our future. Wearable electronics are expected to own a huge market share in the next decade. The rapid development of wearable/flexible electronics raises challenges of reliable and sustainable wearable/flexible energy sources. Facing these challenges, researchers have made great efforts to develop various wearable energy sources involving wearable energy harvesters, wearable energy storage devices and wearable power systems. In this presentation, our recent studies on wearable/flexible sensors and their power systems will be presented. The challenges, future directions and potential applications will also be discussed.

**12** INVITED

## Advances in Metabolite Self-assemblies and Their Energy Harvesting Application

生物分子自组装晶体及能力收集应用进展

**杨如森**

*西安电子科技大学 · 教授*

Biomolecule-based materials can enable technological innovations through their intrinsic bioactivity and physical properties. Designing tailored biomaterials is essential to understand them better, achieve desired properties, and realize their full application potential. Herein, the electronic structures, dielectric, piezoelectric, and elastic properties of biomaterials are revealed by the first-principles calculation. We demonstrate a physical property-enhanced strategy by taking advantage of the hydrogen-bonding networks of double-layer amino acid crystals with their molecular side

chains. We adopt the Stranski-Krastanov (S-K) growth mode and propose a mechanism for the physical vapor deposition growth of ordered amino acid array structures. The growth mode not only explains the formation of uniform, controllable morphologies of amino acid structures but also leads to a significant enhancement of their piezoelectric properties. The biomaterials with excellent thermostability and piezoelectricity are employed in nanogenerators, resulting in much improved performance and demonstrating their potential for eco-friendly energy-harvesting devices.

**13** INVITED

## Wireless and Self-powered Sensing of Water-droplet Motion and its Application to Aircraft Safety Warning.

无线无源水滴运动传感及其飞行器安全预警应用

**梁飞**

*西北工业大学 · 副教授*

Heavy rainfall degrades UAV wing lift by disturbing the surface pressure distribution and promoting premature boundary-layer separation. In-situ droplet monitoring is difficult because wired, powered sensors disturb the flow. We report a self-powered wireless multimode rain-droplet sensor based on an electromagnetically coupled droplet-based electricity generator. By optimizing the electrode–coil coupling geometry, droplet impact and sliding produce a force–electro–magnetic coupled oscillatory signal that radiates a magnetic field and is read out wirelessly, enabling simultaneous sensing of rainfall and rain-laden wind pressure without onboard power or skin wiring. The sensor resolves impact velocity, volume, and angle ($R^2 > 0.98$) and wind pressure from 0–200 Pa. Integrated on a small UAV and closed into a PID loop, it reduced storm-condition 3D position RMSE from 7.34 m to 1.26 m (82.88%). This work provides a route to self-powered, wireless environmental sensing on aircraft skins and to closed-loop flight stability under heavy rain.

**14** INVITED

## AI-Enabled Intelligent Sensing of Human Physiological Signals via Wearable Flexible Sensor Arrays

基于可穿戴柔性传感器阵列的人体生理信号 AI 赋能智能感知

**郑海务**

*河南大学 · 教授*

With the rapid advancement of flexible electronics and artificial intelligence (AI), wearable sensing systems have shown great potential in human motion perception and human-machine interaction. However, the weak amplitude, complex spatiotemporal characteristics, and susceptibility to interference of human biomechanical signals pose challenges to accurate acquisition and intelligent interpretation.[1] Integrating flexible piezoelectric and triboelectric sensors with AI offers a promising approach to high-quality signal acquisition, automated feature extraction, and multidimensional motion perception.

First, a flexible triboelectric hydrogel sensor array integrated with deep learning was developed for self-powered facial expression recognition. By leveraging the flexibility, stretchability, and transparency of hydrogels, the system captured subtle facial muscle movements and achieved an average recognition accuracy of 99.44% for six basic expressions using a one-dimensional convolutional neural network (CNN), with real-time visualization through a three-dimensional virtual avatar.[2] Extending from localized motion recognition to spatial biomechanical perception, a 2 × 8 flexible piezoelectric sensor array combined with multichannel signal conditioning and deep learning algorithms was developed for real-time reconstruction of body-surface morphology and identification of abnormal deformations through curvature-based analysis.[3] Furthermore, to achieve collaborative perception of complex human movements, an embedded AI-enabled wearable piezoelectric sensing cluster was developed. Through piezoelectric composite optimization, differential sensing design, miniaturized signal conditioning, and lightweight CNN deployment on

microcontrollers, the system achieved a signal-to-noise ratio of 72.5 dB and real-time recognition of 20 joint movements via a master–slave wireless architecture.[4]

Collectively, these studies demonstrate the evolution of AI-enabled biomechanical sensing from localized motion recognition to multidimensional morphological perception and distributed collaborative sensing, providing new opportunities for next-generation wearable intelligent systems and natural human-machine interaction.

**15** INVITED

## Mechano-Electric Fiber Materials and Self-Powered Devices

力电纤维材料与自供能器件

**董凯**

*中国科学院北京纳米能源与系统研究所 · 研究员*

Mechano-electric fibers are a new class of intelligent fiber materials that integrate contact electrification or triboelectric mechano-electric conversion mechanisms with fiber-based wearable carriers, demonstrating significant application potential in fields such as self-powered wearable devices, flexible sensing, smart textiles, and human-machine interaction. Addressing key bottlenecks such as the unclear mechanism of interfacial charge generation during the mechano-electric conversion process, the limited energy conversion efficiency of fiber-based devices, and insufficient system integration performance, the team aims to construct an integrated system featuring self-charging power supply, self-powered sensing, and electrical stimulation interaction. Centered on the research direction of "understanding electricity, regulating electricity, and applying electricity," our team systematically reveals the physical mechanisms of interfacial charge generation, migration, and regulation driven by mechanical stimuli, breaks through key technologies for enhancing charge output and energy conversion efficiency of mechano-electric fibers, and constructs self-charging emergency power supply, self-powered intelligent sensing, and electrical stimulation interaction systems oriented toward practical applications. The related research will provide new material foundations and theoretical support for the development of micro-nano energy devices, flexible electronics, smart textiles, and embodied intelligence technologies.

**16** INVITED

## Multimodal Sensing Platforms for Intelligent Health Monitoring

用于智能健康监测的多模态感知平台

**徐琳**

*吉林大学 · 教授*

The rapid advancement of integrated and intelligent electronic technologies has brought about a revolutionary transformation in the fields of telemedicine and environmental monitoring, significantly facilitating non-invasive, real-time tracking of information. By highly integrating sensors, data processing modules, and wireless communication technologies, modern electronic systems are now capable of precisely capturing and transmitting critical data in real time. This report examines the application of semiconductor sensors across various domains, focusing on the functional design of micro- and nano-integrated devices. In the realm of breath analysis, the report explores the use of semiconductor sensors for the highly sensitive detection of trace gas molecules. Furthermore, it investigates the design of integrated biosensors for identifying specific biomarkers in bodily fluids, enabling early disease screening and real-time monitoring. In the sector of smart agriculture, the report explores the deployment of micro- and nano-sensor networks for comprehensive, all-encompassing monitoring of agricultural environments.

17 ORAL

## Contact-Electro-Dynamic Therapy (CEDT): A New Strategy for Reactive Oxygen Species-Mediated Therapy

**Haimei Li 李海梅**

*South-Central Minzu University, China*

Conventional catalytic approaches for generating reactive oxygen species (ROS) in biological systems are constrained by the limited availability of endogenous reaction substrates, making it challenging to overcome the ceiling on ROS production. To address this limitation, we developed a perfluorocarbon (PFC) nanoemulsion-based PFC–H2O liquid–liquid interfacial system. Ultrasound induces high-frequency contact and separation between water molecules and PFC, triggering contact-electro-catalysis (CEC). During this process, PFC captures electrons from water molecules, resulting in the formation of hydroxyl radicals (·OH). Oxygen subsequently accepts electrons from negatively charged PFC* to generate superoxide radicals (·O2−), while PFC* returns to its initial state upon electron transfer. Based on this mechanism, we propose contact-electro-dynamic therapy (CEDT) as a new approach to cancer treatment. Through liquid–liquid contact between PFC and water in the tumor microenvironment, CEDT continuously generates ·OH and ·O2−, activating T cell-mediated antitumor immune responses to achieve tumor ablation.

Furthermore, we identified an alternative reduction pathway in which H2O2 serves as an electron acceptor in the CEC system. Whereas the conventional oxygen reduction reaction (ORR) requires an external energy input, such as ultrasound, the reduction of H2O2 to ·OH can proceed without ultrasound and exhibits substantially higher catalytic efficiency than the ORR pathway. This finding elucidates the critical role of H2O2 in CEC and overcomes the conventional reliance on oxygen reduction for ROS generation. It also demonstrates the potential to exploit elevated endogenous H2O2 levels in the tumor microenvironment as a substrate for efficient ·OH generation. These findings provide a theoretical basis for improving CEC catalytic efficiency and developing nanocatalytic therapeutic platforms that operate without external stimulation.

18 KEYNOTE

## Harnessing Mechanical Energy for Light Emission

**Feng Wang**

*City University of Hong Kong, Hong Kong, China*

Mechanical energy that is ubiquitously available in nature can provide sustainable solutions to challenging problems in the fields of biology and optoelectronics as well as energy and environmental sciences. In this talk, I focus on our recent efforts to incorporate lanthanide and transition ions into nano/microstructure crystals for achieving tunable emissions under mechanical action. We demonstrate rational control over luminescence processes and properties by leveraging characteristics of the host materials and their complex yet manageable interactions with various dopant ions. We show that these doped mechanoluminescent materials hold promise in many exciting applications in sensing, information security, and biomedical sciences.

19 KEYNOTE

## Extending the cycle life Li anode

**Quan Li**

*The Chinese University of Hong Kong, Hong Kong, China*

The lithium (Li) metal battery is a highly promising candidate for high energy density applications. However, the poor long-cycle stability of the Li metal anode limits its practical implementation. In this talk, I will start with the discussion of the leading failure mechanism of Li metal anode, which turns to be the accessibility of fresh Li in the electrode. I will then discuss the impact of surface crystallographic texture on the plating/stripping characteristics of Li metal and its

influence on electrode cycle performance. Specifically, (110) textured lithium facilitates not only dense lithium plating but also uniform stripping during cycling, leading to largely extended cycle life of the cell.

20 KEYNOTE

## Materials Design and Control of Functionalities of Electrochemical Artificial Neurons and Synapses

**Ilia Valov**

*Peter Grünberg Institute (PGI-7), Forschungszentrum Jülich, Germany*

Nanoionic memristive devices have significantly developed in the last decade, expanding their application horizon. Especially important is their functionalities as artificial neurons and synapses, making them promising building units for the next generation bio-inspired neuromorphic hardware. Despite a lot has been learned about materials design and the operation principles of these devices, recent research has shown that fundamentals still can be significantly amended, demonstrating new operation principles and functionalities. In this lecture, different ways to control and tune neuromorphic behaviour will be discussed as well as new aspects on materials design and its influence on the physicochemical processes and resulting functionalities. The selection of different materials is changing the electrochemical nanoionics processes and as well the performance of the artificial neurons and synapses. The magnitude of the applied voltage, thickness of materials and layers appear of special importance and as well the combination of thicknesses of all involved functional films. The interplay between the Schottky and electrochemical Redox barriers will be highlighted and critically discussed. A new, alternative approach for reducing the variability of states and stabilization of performance will be demonstrated. Special attention will be paid to new applications and developments. As an example, the use of quantum conductance levels as standard for resistance in accordance with the new directions given by SI will be discussed.

21 KEYNOTE

## Title to be announced

**Ni Zhao**

*The Chinese University of Hong Kong, Hong Kong, China*

*Abstract not received at the time of printing.*

22 KEYNOTE

## Device-Level AI with Intelligent Sensing and Neuromorphic Hardware

**Hocheon Yoo**

*Hanyang University, Korea*

This talk presents device-level approaches toward intelligent sensing and neuromorphic hardware, where sensing, computing, and stochasticity are directly embedded into emerging electronic and optoelectronic devices. I will introduce our recent developments in adaptive sensors, neuromorphic transistors, and stochastic hardware for efficient information processing and probabilistic computing. These device concepts provide new opportunities for compact, energy-efficient, and hardware-native AI systems.

23 INVITED

## Chemistry at Contact Electrification Interfaces: Catalytic Reactions and Biomedical Opportunities

**Peng Jiang**

*Wuhan University, China*

*Abstract not received at the time of printing.*

24 ORAL

## Micro-nano Structure Modulation by Capillarity Manipulation at the Liquid-Solid-Gas Three-phase Boundaries and Its Applications in Smart Mechano-responsive Materials

**Yang Liu**

*Sun Yat-sen University, China*

*Abstract not received at the time of printing.*

25 ORAL

## Self-powered Luminescent System

**Junlu Sun**

*Zhengzhou University, China*

*Abstract not received at the time of printing.*

26 ORAL

## RF Oscillator-based Battery-free Self-powered Instantaneous Wireless Sensing System

**Jinkai Chen**

*Hangzhou Dianzi University, China*

*Abstract not received at the time of printing.*

27 ORAL

## Twist Contact-Based Skew-Gaussian Transistor and Integrated Classification Hardware System

**Youngmin Han**

*Hanyang University, Korea*

*Abstract not received at the time of printing.*

28 ORAL

## Interface Engineering for High-performance Near-room-temperature Thermoelectric Films

**Qingxue Hu**

*Nanjing University of Science and Technology, China*

*Abstract not received at the time of printing.*

29 ORAL

## The Application of TENG in Intelligent Transport Systems

**Yikang Li**

*Changchun University of Technology, China*

*Abstract not received at the time of printing.*

30 ORAL

## A Wearable Bimodal Sensing System with Physics-Guided Early Decoding for Low-Latency Motor Intent Inference

**Jiarui Zhao**

*University of Chinese Academy of Sciences, China*

*Abstract not received at the time of printing.*

31 ORAL

## A Stretchable Droplet Electricity Generator Enabled by Gradient-Charged Interfaces

**Lei Lv**

*Northwestern Polytechnical University, China*

*Abstract not received at the time of printing.*

32 ORAL

## Topological Proprioception at the Wrist for Human-Machine Interaction

**Meihua Zhou**

*University of Chinese Academy of Sciences, China*

*Abstract not received at the time of printing.*

33 ORAL

## Atomically Confined Insertion for 2D Strain and Polarization Engineered GaN Electronics

**Yuanhong Shi**

*University of Chinese Academy of Sciences, China*

*Abstract not received at the time of printing.*

# 分论坛四

SYMPOSIUM 04 · MEDICAL-ENGINEERING INTERDISCIPLINARY RESEARCH

医工交叉与智能材料器件

04

AI EMPOWERMENT · MATERIALS INNOVATION · INTELLIGENT MANUFACTURING

01 KEYNOTE

## Research basis and translational application exploration of nanobiological adaptation

纳米生物适配的研究基础和转化应用探讨

**Xingjie Liang 梁兴杰**

*National Center for Nanoscience and Technology, CAS, China · 研究员*

As a natural protein material with over five thousand years of history, silkworm silk is not only widely used in traditional textiles but also occupies an important position in the field of functional materials. China's abundant natural silk resources provide unique advantages for its in-depth research and development, making it a highly promising flexible wearable functional material. In recent years, silk fibers have attracted considerable attention due to their potential applications in sensing, actuation, energy, and other fields. Exploring high-performance and scalable application pathways for silk fibers is of great significance. A thorough investigation into the structure, preparation, and functionalization of silk fibers serves as an essential foundation for unlocking their application potential. In this talk, I will introduce the unique structure and properties of silk materials, and based on research examples, illustrate how innovative methods such as regeneration or compositing can endow silk with new mechanical, electrical, and optical properties. Meanwhile, we will discuss the application potential of these novel silk fiber materials in intelligent wearable devices, biomedical monitoring, sustainable development, and other fields, aiming to provide valuable references for the study of natural fiber materials.

02 KEYNOTE

## Ionic transport behavior and application of polyelectrolyte confinement

聚电解质限域的离子传输行为及应用

**Ping Yu 于萍**

*Institute of Chemistry, CAS, Beijing, China · 研究员*

Nanofluidic ionotronics has been named one of the top ten emerging fields of IUPAC 2024. Its essence is to develop various functional devices such as ion sensing, ion circuits, ion computing chips, etc. by manipulating ion transport under limited conditions. Therefore, developing a confined system of natural ion channels and studying their confined ion transport behavior has become a key issue in this field. The reporter has long been engaged in basic and applied research on ion transport, and has intersected with neuroscience to conduct research on confined fluid memristors and neuromorphic functions. In this report, the research group will share their recent efforts in constructing a polyelectrolyte confined ion transport system, systematically studying abnormal ion transport behaviors such as ion current rectification, ion current rectification reversal, and negative differential resistance. Based on this, they have regulated these confined ion transport behaviors and conducted two aspects of applied research:

1) A microscale asymmetric ion transport model was proposed, and a new principle and method for high spatiotemporal resolution in vivo in situ analysis based on microtubes were developed; Solved key scientific issues in brain chemistry measurements for regulating ion transport; Realized in vivo quantitative analysis of substances such as ATP, DA, pH, H2O2, etc;

2) The memristive behavior of ion transport systems with polyelectrolyte confinement was systematically studied, and the simulation of neurochemical and electrical signal transduction was achieved for the first time using a single device; Developed ion selective neuromorphic devices and achieved neuromorphic functional simulation of biological like channels.

03 KEYNOTE

## Electroactive Biomaterials and Tissue Repair

电活性生物材料与组织修复

**Zhou Li 李舟**

*Tsinghua University, China · 教授*

Bioelectric signals are key regulatory factors in maintaining vital functions and tissue homeostasis, and they play a role in processes such as cell migration, proliferation, and differentiation. Electroactive biomaterials can generate and transmit electrical signals through electron or ion transfer, as well as electrical energy conversion, thereby providing new regulatory mechanisms for tissue repair. This study focuses on electroactive biomaterials, including piezoelectric materials, triboelectric materials, conductive materials, ion electric materials and electricity-generating microorganisms, with particular emphasis on their electrical properties, biodegradability, and tissue repair effects. By regulating intermolecular bonding, inducing crystallization at polymer interfaces, and controlling molecular composition and functional groups, it is possible to effectively improve the electrical properties of materials and develop electroactive material systems with biocompatibility and degradability. The local electrical signals generated by electroactive biomaterials can act on ion channels and ion pumps such as Piezo and Na+/K+-ATPase, promoting Ca2+ influx and second messenger cascade reactions. This further regulates signalling pathways such as PI3K/AKT, MAPK/ERK, and Wnt, thereby influencing cell function and reshaping the tissue repair microenvironment. Relevant electroactive materials have demonstrated the ability to promote re-epithelialization, nerve regeneration, and osteogenic differentiation in skin wounds, peripheral nerves, and bone tissue repair. In summary, electroactive biomaterials can regulate cellular electrical responses and the tissue repair microenvironment through their electrical properties, ultimately achieving tissue repair and providing a new material foundation and research direction for regenerative medicine.

04 KEYNOTE

## Intelligent biomimetic scaffold driven by bacterial energy promotes the repair of infectious bone defects

利用细菌能量驱动的智能仿生支架促进感染性骨缺损修复

**Yan Liu 刘燕**

*Peking University, China · 教授*

The repair of infectious bone defects faces multiple challenges, including persistent bacterial infection, imbalanced local immune microenvironment, and hindered bone tissue regeneration. Traditional antibacterial biomaterials focus on pathogen clearance, but often overlook the potential metabolic value contained in "bacterial debris". How to transform pathogens from infection burden into beneficial resources for tissue repair provides new research ideas for the design of new generation intelligent biomaterials.

This study is based on the multi-level structure of natural bone tissue, and constructs an ultrasound responsive intelligent biomimetic scaffold composed of oxygen vacancy titanium dioxide nanorods and type I collagen assembled through fibrous mineralization. It explores a treatment strategy for infectious bone defects that integrates efficient antibacterial, bacterial energy conversion, and immune metabolism regulation. Under ultrasound stimulation, the scaffold not only achieves efficient antibacterial activity, but also forms bacterial debris with higher intracellular protein accessibility. Research has found that these bacterial remnants are more easily taken up and degraded by macrophages, accompanied by immune metabolism remodeling characterized by glutamine related metabolism, improved mitochondrial energy metabolism function, and enhanced antibacterial and reparative functions of macrophages. This strategy utilizes the immune microenvironment characteristic of "transforming bacteria into energy" to drive the repair and regeneration of infectious bone defects with bacterial energy.

This report will discuss the structural design of biomimetic scaffolds, ultrasound responsive antibacterial mechanisms, macrophage metabolic remodeling mediated by "bacterial debris", and infectious bone defect repair, providing new ideas for the design of intelligent anti infective regenerative materials from "bacterial clearance" to "bacterial utilization"

05 KEYNOTE

## Discovery of enzyme activity

酶活的发现

**Huiyu Liu 刘惠玉**

*Beijing University of Chemical Technology, China · 教授*

As efficient and specific catalysts in living organisms, the discovery of enzyme activity has had a profound impact on the development of modern biotechnology, and the in-depth analysis of structure-activity relationships and mechanisms of action has further promoted the development of modern industry and medicine. The discovery of nanoenzyme activity has broken the boundary between traditional enzymes and artificial catalysts, providing new ideas for fields such as biomedical, environmental governance, and industrial catalysis. Taking inspiration from the natural enzyme metal nitrogen (M-N) coordination active center, we constructed a biomimetic single atom nanoenzyme with an "M-N4" structure through rational design, and further optimized the design of a N-five coordinated single atom iron-based nanoenzyme (Fe-N5). This nanoenzyme not only has a structure closer to the natural enzyme active center, but also exhibits superior biocatalytic performance, showing great potential for applications in fields such as tumor catalytic therapy, neuroprotection, and biosensing. In addition, our "photo controlled nanoenzyme" strategy based on enzyme activity mechanism, which enhances the therapeutic efficiency of nanoenzymes through near-infrared light excitation, further expands its application prospects. This report focuses on the discovery of enzyme activity, analysis of structure-activity relationships, activity regulation, and their broad future in basic research and practical applications.

06 KEYNOTE

## Reversing Abnormal Phase Separation for Disease Treatment

逆转疾病治疗中的异常相分离

**Tingting Li 李婷婷**

*Peking University, China · 教授*

The membraneless organelle formed by intracellular phase separation is a multidimensional complex system containing proteins, RNA, and DNA. Artificial intelligence technology provides a new approach for deep decoding of membraneless organelles. This report mainly introduces the prediction methods of phase separated proteins and their applications in drug target discovery, drug intervention, and targeting efficiency, as well as the calculation and screening methods for targeting abnormal phase separated small molecule drugs and improving the targeting efficiency of small molecule drugs based on the microenvironment of phase separated aggregates.

07 KEYNOTE

## Cluster-based Enzymes and the Repair of Neural Injury

团簇酶与神经损伤修复

**Xiaodong Zhang 张晓东**

*Tianjin University, China · 教授*

Clusterzymes are atomically precise, ultrasmall (~2 nm) biomaterials with enzymatic activity, holding broad application prospects in neuroscience, imaging medicine, and related fields. Over the past decade, our research has focused on the theme of “Clusterzymes for neurotrauma repair,” addressing the major clinical needs of neurotrauma. By designing and developing various Clusterzymes, we have achieved interventions across the acute, subacute, and chronic phases of neurotrauma, providing novel strategies for full-pathology-cycle therapeutic intervention in clinical neurotrauma.

For acute-phase neurotrauma, we proposed and designed a new generation of artificial enzymes-“Clusterzymes” , which possess ultrahigh antioxidant activity, enabling early intervention in acute neuroinflammation and injury. For subacute-phase neurotrauma, we developed “multi-enzyme-activity” Clusterzyme hydrogels, whose catalytic activity is 20 times that of natural enzymes, achieving highly efficient healing of subacute neurotrauma through immunomodulation. For chronic-phase neurotrauma, we designed “ultrastable” Clusterzymes and neural recording electrodes, which can effectively alleviate chronic neuroinflammation and improve neurological cognitive function; these electrodes achieved 12 months of safe and stable neural recording — six times longer than clinical electrodes.

08 KEYNOTE

## Biomaterials for Reactive Oxygen Species Homeostasis Regulation

活性氧稳态调节的生物材料

**Ping’ an Ma 马平安**

*Harbin Engineering University, China · 教授*

Reactive oxygen species (ROS) are tightly implicated in tumor initiation and progression. Perturbing intracellular ROS levels to break the safe threshold of redox homeostasis can inflict irreversible, nonselective oxidative damage to cancer cells and trigger diverse programmed cell death modalities. Importantly, ROS act not only as key effector molecules in innate immunity but also facilitate the maturation and differentiation of antigen-presenting cells. This cascade further shapes adaptive immune responses, laying the foundation for ROS-enabled cancer immunotherapy. Fueled by advances in nanotechnology, a spectrum of ROS-centered nanotheranostic paradigms have been extensively developed, including photodynamic, sonodynamic, chemodynamic, radiation, and enzyme-mediated therapies, opening new avenues for next-generation anticancer therapeutics.

Over the past five years, our group has centered its research on biomaterials for ROS homeostasis regulation and engineered a library of functional inorganic nanomaterials. First, we have established a dual-dimensional strategy that tunes ROS homeostasis via electron and ion modulation. This approach orchestrates intracellular ROS-associated chemical reactions to amplify oxidative stress, surmounting major bottlenecks imposed by the tumor microenvironment on ROS-based therapeutic modalities. Second, we have constructed a panel of ROS-regulatory inorganic nanoadjuvants and nanovaccines, capable of precisely eliciting immunogenic cell death and pyroptosis. By rewiring tumor metabolic circuits, these nanoplatforms potentiate antitumor immunity. This work offers fresh perspectives on unlocking the intrinsic immunogenicity of nanomaterials and devising in situ cancer vaccines.

**09 KEYNOTE**

## Bioactive Poly(amino acid) Materials

生物活性聚氨基酸材料

**Jianxun Ding 丁建勋**

*Institute of Applied Chemistry, CAS, Changchun, China · 研究员*

Poly(amino acid) materials are a class of high-value-added, high-technological-barrier biomedical polymers composed of amino acids as structural units. They offer key advantages, including structural diversity, excellent biosafety, modifiable functional groups, favorable bioresponsiveness, and controllable secondary structures, and show strong application potential in frontier fields, such as drug and gene delivery, immune regulation, and regenerative medicine. In our research, we have constructed a series of poly(amino acid) materials with specific bioactivities that directly regulate cell behaviors, such as proliferation, migration, and differentiation. In cancer therapy, these materials form three-dimensional (3D) network structures in situ within tumors, effectively inhibiting tumor growth and metastases and showing promising prospects for clinical translation. For tissue repair, we have developed biomechanically dynamic, adaptive hydrogels for osteochondral repair, highly hydrophilic and osteoinductive artificial bone materials, and chronic wound dressings with combined anti-inflammatory and pro-regenerative functions, thereby advancing the development of multiple categories of innovative medical devices. Overall, bioactive poly(amino acid) materials hold significant value for fundamental research and broad prospects for clinical application in treating cancers and other diseases, as well as in tissue regeneration and repair.

**10 KEYNOTE**

## Engineering Adaptive Bioelectronics for Living Systems

生命系统工程自适应生物电子学

**Changsheng Wu 吴昌盛**

*National University of Singapore, Singapore · 教授*

Bioelectronic technologies offer opportunities to investigate physiological processes across tissues and organisms. Their performance depends on how effectively materials and device architectures accommodate biological environments, manage fluid and ion transport, and maintain function under mechanical deformation. This seminar will present examples of engineering these interactions through responsive materials, mechanics-guided design, and coupled transport processes.

At tissue interfaces, responsive hydrogels enable stable cortical coupling and benign detachment for multimodal intraoperative monitoring, while programmable three-dimensional biointerfaces support engineered cardiac tissue assembly and volumetric electrophysiological recording. In plants, PlantIonics, a non-invasive, sweat-inspired wearable platform, combines microfluidic collection with electrochemical sensing to monitor guttation biomarkers and the leaf microenvironment. In electronic textiles, magneto-mechano-electrochemical fibers couple magnetic fields with ion transport to stabilize energy storage under deformation. Together, these studies illustrate how engineering interfacial contact, structural mechanics, and transport processes can enable adaptive bioelectronics for physiological monitoring, tissue engineering, and wearable systems.

11 INVITED

## Biomimetic assembly of lanthanide nanomaterials and their hemostatic application research

镧系纳米材料仿生组装及其止血应用研究

**Jing Yu 余靓**

*Zhejiang University of Technology, China · 教授*

Hemostatic materials, especially emergency hemostatic materials, are the "golden key" for battlefield, clinical surgery, and even daily life rescue. Although various hemostatic materials have been developed in the past few decades, it is still difficult to simultaneously meet the two major contradictions of "rapid hemostasis" and "avoiding disseminated intravascular coagulation", "injectability" and "high strength". In addition, efficient hemostasis for complex conditions such as coagulation disorders remains a major challenge in this area of research.

In this study, we utilized the responsive multilevel assembly of lanthanide nanofibers to $OH^-$ to construct a biomimetic material that simulates the coagulation cascade process. This material presents a colloidal state under acidic (pH<5) conditions, endowing it with injectability and potential to adapt to various irregular and complex wounds. With the increase of pH value (pH>5), the material can gradually change into gelled state through assembly. This material forms a gel in situ on the wound surface, giving it high strength and adhesion to the wound. The responsive gelation of $OH^-$ makes its hemostatic effect better than that of a small amount of bleeding in cases of massive bleeding. The results of the thromboelastography show that the hemostatic effect of the material is not achieved by regulating the body's own coagulation pathway, but by establishing a physical hemostasis method that mimics the coagulation cascade externally. Therefore, the material also has a significant hemostatic effect on blood with coagulation disorders. In addition, due to its anticoagulant effect on blood, this material is less likely to cause disseminated intravascular coagulation in vivo, which is expected to improve safety.

In summary, this study is expected to provide an emergency and safe hemostatic material for people with coagulation disorders in complex situations such as massive bleeding and coagulation disorders.

12 INVITED

## Mechano-electrical Coupling Materials and Devices for Physical Therapy

面向物理治疗的力电耦合材料与器件

**Dan Luo 罗聃**

*Beijing Institute of Nanoenergy and Nanosystems, CAS, China · 研究员*

Living organisms contain a multitude of sophisticated, complex functional interfaces with unique physical properties. These interfaces regulate biological activities through physical interactions occurring across various structural levels of the organism. Such natural physical regulatory phenomena offer vital insights for biomedical research; it is anticipated that the artificial construction of functional interfaces—characterized by unique structures and superior physical properties—will provide a novel research paradigm for uncovering the fundamental principles of life and intervening in disease progression. Our research focuses on the mechanisms by which functional interfaces physically regulate living systems. By integrating theories and techniques from physics, chemistry, materials science, and electronics, we address critical challenges in the life sciences through an interdisciplinary approach. We have developed strategies—including thermodynamic optimization, kinetic control, and template-confined regulation—to construct biomimetic functional interfaces that replicate the mechanical and electrical environments found in biological systems. Furthermore, we utilize these interfaces to assemble mechano-electrically coupled biomaterials, elucidating how their mechanical and electrical characteristics govern cellular activity and fate. Additionally, we develop bioelectronic devices based on the layered, stacked structures of these functional interfaces; by leveraging mechano-electrical transduction, these devices find applications in fields such as tissue engineering and biomimetic sensing. This body of

work lays the foundation for the development of innovative tissue-engineering materials and high-performance medical devices with significant potential for clinical translation.

**13 INVITED**

## Full-API Nanodrugs (FANDs) and Their Biomedical Applications

全活性纳米药物（FAND）构建及其生物医学应用研究

**Jinfeng Zhang 张金凤**

*Beijing Institute of Technology, China · 教授*

Nanomedicine offers new opportunities for the advancement of biomedicine. However, the translational potential of conventional nanomedicines is often limited by several challenges, including low active pharmaceutical ingredient (API) content, potential immunogenicity associated with carriers, and complex fabrication processes. To address these challenges, we pioneered the concept of Full-API Nanodrugs (FANDs), which are constructed from naturally occurring, intrinsically bioactive components. FANDs can be composed of various active components, including bioactive metal ions, organic small-molecule drugs, biological macromolecular therapeutics, and bioactive biomimetic components. The FAND concept encompasses a broad range of nanomedicines, including carrier-free (or self-delivering) nanomedicines, formulations based on therapeutic carriers, and emerging biomimetic nanodrug delivery systems derived from biological components with intrinsic therapeutic activity. This innovative concept substantially expands the toolbox for developing highly effective and low-toxicity nanomedicines, offering new possibilities for the treatment of major diseases.

**14 INVITED**

## Design of Machine-Learning-Assisted Photo-Enzyme Integrated Catalysts

机器学习辅助光酶集成催化剂的设计

**Xin Yu 于欣**

*University of Jinan, China · 教授*

Bacterial infections pose a severe threat to global public health security. Conventional antibacterial technologies such as chlorination, ozonation and antibiotic-based therapies have notable drawbacks. They not only tend to generate toxic by-products and cause environmental pollution, but also induce bacterial drug-resistance and the emergence of superbugs, which greatly hinder the advancement of clinical antibacterial treatments. Although single photocatalytic antibacterial technology features the merits of environmental friendliness and non-drug-resistance, it suffers from limited catalytic activity and unsatisfactory bactericidal efficiency. A synergistic photo-enzyme integrated catalytic system coupling photocatalysis with nanozymes offers a new strategy for high-efficiency antibacterial therapy[1-2]. This study introduces AI-empowered material research and development to perform intelligent screening for hydrotalcite-based systems. Hydrotalcites are a family of layered double-metal hydroxide nanomaterials with unique structures, whose micro-morphology, metal-ion ratios and interlayer anions can be flexibly tuned. Machine learning is adopted to explore structure-activity relationships, rapidly predict candidate systems within the vast compositional space, and directionally screen hydrotalcites with precisely optimized optical properties and enzyme-mimicking catalytic activities, so as to efficiently construct controllable photo-enzyme integrated catalytic systems. Meanwhile, the screened hydrotalcite materials exhibit favourable biocompatibility, low biological toxicity and outstanding biosafety, making them suitable for in-vivo infection-treatment scenarios. These materials achieve deep synergy between photocatalysis and nanozyme-catalysis. Driven by natural light, they produce abundant reactive free radicals, which, combined with enzyme-mimicking catalytic effects, continuously disrupt bacterial structures, thus exerting broad-spectrum bactericidal efficacy against both Gram-positive and Gram-negative bacteria. In addition, the hydrotalcite nanomaterials obtained via AI-assisted screening possess high stability and long-term bacteriostatic capacity. Their bactericidal process is eco-friendly and pollution-free without triggering bacterial drug-resistance. They

effectively compensate for the deficiencies of traditional antibacterial techniques and single catalytic systems, holding promising application prospects in bacterial-infection therapy and clinical antibacterial fields.

**15 INVITED**

## Inorganic Functional Nanomaterials for Tumor Immunotherapy

用于肿瘤免疫治疗的无机功能纳米材料

**Chunxia Li 李春霞**

*Shandong University, China · 教授*

Malignant tumors pose a significant threat to human health, with over 90% of tumor-related deaths attributed to metastasis. How to overcome the immunosuppressive tumor microenvironment and tumor metastasis is the main challenge. In this context, we have designed a range of nanocomposites to address the aforementioned challenges.

(1) A multifunctional immunomodulator is engineered for near-infrared light (NIR)-triggered photodynamic-metal-metabolic immunotherapy. An endogenous and exogenous stimuli-responsive nanoagent was prepared using chlorin e6 (Ce6)-modified dense silica-coated rare earth-doped nanoparticles (ReNPs@SiO2(Ce6)), with ZIF-8 grown in situ on the surface for loading two energy inhibitors. This material induced energy depletion by inhibiting glucose transport and glutamine metabolism, while mitochondrial damage under NIR irradiation released mtDNA, synergistically activating the cGAS-STING pathway with Zn2+, initiating type I interferon responses, and reshaping the tumor immune microenvironment.

(2) Pre-metastatic niches (PMNs) play a prerequisite role in metastasis, and blocking their formation is vital to inhibiting tumor cell spread. An oxygen-independent NIR-triggered multiple-phototherapy nanoplatform was designed using orthogonal UCNPs modified with dual photosensitizers. Under 808/1550 nm excitation, ROS was generated to achieve normoxic/hypoxic-compatible phototherapy, directly killing tumor cells and depleting CAFs. Meanwhile, surface-coated copper-shikonin induced cuproptosis-pyroptosis and released damage-related molecular patterns, thereby alleviating immune suppression and blocking the formation of PMNs.

(3) A "metal chelation therapy" method has been proposed. D-penicillamine coordinated with Zn2+ to form Zn-PEN, which depleted copper in tumor cells and promoted Zn2+ accumulation, achieving synergistic antitumor, antibacterial, and antimetastatic effects. Furthermore, EDTA-Mg was designed to chelate Ca2+ on tumor-cell surfaces, artificially initiate epithelial-mesenchymal transition, and subsequently chelate ferritin-derived Fe2+, promoting lysosomal rupture and ferroptosis through Fenton-like reactions. Ferroptosis combined with Mg2+ release synergistically enhanced immune responses and inhibited tumor metastasis.

**16 INVITED**

## Aqueous Supramolecular Polymerization of Biodegradable Nanoparticles via Pre-assembly Guided Disulfide Exchange Reaction

通过预组装引导的二硫化物交换反应实现可生物降解纳米粒子的水性超分子聚合

**Bingran Yu 俞丙然**

*Beijing University of Chemical Technology, China · 教授*

This study presents an aqueous strategy for the controlled construction of multicomponent organic nanoparticles via supramolecular preassembly-mediated disulfide exchange polymerization. Pre-assembly of hydrophobic and hydrophilic monomers generates spatially confined and ordered aggregates that shorten reactive-site distances, promote disulfide exchange, and enable continuous size regulation. Simulations reveal rapid aggregate formation in water and a pre-reactive short-range contact state at ~0.6 nm. Using methylene blue-lipoic acid and mannose-lipoic acid as model monomers, we obtained macrophage-targeting, stimuli-responsive nanoparticles that release methylene blue in response to elevated hypochlorous acid in infected macrophages and achieve efficient photodynamic

eradication of intracellular bacteria. The platform shows favorable targeting, responsiveness, biosafety, and in vitro/in vivo antibacterial efficacy, providing a mild and programmable route to multifunctional organic nanomaterials.

**17 INVITED**

## Interface Design and Functional Modulation of Metallic Implants for Infection Control and Osseointegration

感染控制和骨整合金属植入物的界面设计和功能调节

**Wenhao Zhou 周文昊**

*Northwest Institute for Nonferrous Metal Research, China · 高级工程师*

Periprosthetic joint infection (PJI) and aseptic loosening are the primary causes of medical metal implant failure, and a fundamental conflict exists between the "aggressiveness" required for bactericidal action and the "mild" microenvironment required for tissue integration. This report adopts surface nanostructuring and composite coating strategies to modify the interface of medical metals. Micro/nanostructured surface layers were fabricated by dealloying, antibacterial coatings were constructed via heterojunction design, and antibacterial thin films were deposited to form continuous functional layers, achieving synergistic enhancement of "antibacterial activity–osteogenesis promotion." The modified surfaces significantly inhibited bacterial adhesion and biofilm formation, while exhibiting low cytotoxicity; osteoblast adhesion, spreading, and proliferation were enhanced, with upregulated ALP activity, mineralized nodule formation, and RUNX2 and OCN expression. Mechanistically, the nanostructures reduced bacterial colonization through physical disruption and interfacial regulation, while the heterojunction/functional coatings maintained long-acting antibacterial performance via enhanced interfacial charge transfer, reactive oxygen species (ROS) generation, and synergistic ion release. Coating adhesion stability and corrosion/wear resistance were generally maintained or improved, although long-term durability under complex in vivo environments requires further optimization. This strategy provides a feasible pathway for multifunctional implant surface design.

**18 INVITED**

## Chiral Assemblies for the Disaggregation of Amyloid Fibrils in Neurodegenerative Diseases

神经退行性疾病中淀粉样纤维解聚的手性组件

**Ke Hou 侯珂**

*Harbin Institute of Technology (Shenzhen), China · 教授*

Pathological amyloid fibrils are key drivers of neurodegenerative diseases. Here, we present chiral assemblies as a strategy for disaggregating Alzheimer's disease tau fibrils. D-peptides that combine tau binding with self-assembly co-assemble along tau fibrils, generate structural strain, and induce rapid fibril fragmentation through a strain-relief mechanism. The resulting products show reduced seeding activity. This mechanism further guides the design of tau-targeted chiral nanomedicine and may provide a general framework for developing amyloid disaggregators against neurodegenerative diseases.

**19 INVITED**

## Antibacterial Biomaterials Based on Cuproptosis-Like Mechanisms

基于类杯状机制的抗菌生物材料

**Xianwen Wang 王咸文**

*Anhui Medical University, China · 教授*

The continuous spread of bacterial antibiotic resistance poses a serious threat to global public health, highlighting the urgent need for antibacterial strategies based on novel mechanisms. Cuproptosis is a recently discovered form of copper-dependent cell death in eukaryotic cells. Our studies have revealed that copper-based nanozymes, including

CuS@MoSe2, CuCo2O4, and Cu-GA-VAN, can induce a similar “cuproptosis-like” effect in prokaryotic bacteria, effectively eliminating drug-resistant pathogens and reversing antibiotic resistance, thereby opening new avenues for antibacterial therapy.1-3. Mechanistically, Cu2+ released from these nanozymes can penetrate bacterial barriers and preferentially accumulate in the bacterial cytoplasm. The accumulated copper ions irreversibly bind to lipoylated proteins, triggering their oligomerization and aggregation, accompanied by the loss of iron-sulfur cluster proteins. These events subsequently disrupt the tricarboxylic acid (TCA) cycle and impair the activities of respiratory chain complexes I and II 4,5. By targeting critical nodes of bacterial metabolism, this cuproptosis-like mechanism bypasses the conventional modes of action of antibiotics, enabling efficient eradication of antibiotic-resistant bacteria while suppressing the expression of resistance-associated pathways.

Building on these mechanistic insights, we have developed a series of intelligent nanozyme platforms capable of inducing bacterial cuproptosis-like cell death. Through targeted functionalization, these nanozymes achieve selective antibacterial activity against pathogenic bacteria. In various infection models, these nanozymes not only effectively eradicate drug-resistant bacteria and disrupt bacterial biofilms but also promote tissue repair, demonstrating dual antibacterial and regenerative functions.

Collectively, our findings identify bacterial cuproptosis-like cell death as a promising antibacterial mechanism and establish a theoretical and technological foundation for developing next-generation targeted antibacterial nanomedicines to combat antibiotic resistance.

**20 INVITED**

## Design and Applications of Electroactive Biomaterials

电活性生物材料的设计与应用

**Jiajun Qiu 邱家军**

*Shanghai Institute of Ceramics, Chinese Academy of Sciences · 副研究员*

Electroactive biomaterials are a new generation of "smart" biomaterials that can generate electrical signals or undergo electron transfer. Organisms, tissues, cells, and biomolecules undergo changes in potential and polarity during biological activities, resulting in bioelectric phenomena. Therefore, mastering the interaction relationship between electroactive biomaterials and biological systems is expected to achieve precise regulation of life activities for disease monitoring and tissue repair. Despite the enormous potential of electroactive biomaterials in tissue repair and disease diagnosis and treatment, continuous breakthroughs are still needed in the design of self-powered power sources, analysis of electron transfer mechanisms at the bio-material interface, and biocompatibility to achieve a leap from concept validation to practical applications.

21 INVITED

## Caries Prevention and Treatment Materials

龋病防治材料

**Chunmei Ding 丁春梅**

*Sichuan University, China · 助理教授*

The oral cavity is the most complex open environment of the human body, harboring more than 700 species of microorganisms. Dental caries, the most common oral bacterial infectious disease, is primarily caused by acid produced through microbial metabolism. According to the Fourth National Oral Health Epidemiological Survey, the caries prevalence rate among children and the elderly in China is as high as 70–98%. However, most existing remineralization materials have been developed based on in vitro tooth models, neglecting the unique plaque microenvironment and pathological structure of natural caries, resulting in unsatisfactory efficacy in vivo. The root cause lies in the lack of precise intervention capability targeting the dynamic processes of bacterial adhesion–acid production–demineralization in the living oral environment.

This work examines the initiation and progression of dental caries from a materials science perspective and proposes a multi-element synergistic adaptive strategy based on interfacial energy modulation to inhibit bacterial adhesion and pH-responsive antibacterial/remineralization functions. This enables materials to perceive pathological microenvironmental changes and respond actively, bridging the gap from passive repair to intelligent prevention and treatment. We systematically quantified the surface and interfacial properties of tooth surfaces across different age groups and found that the polar force and total interfacial energy of primary tooth surfaces are significantly higher than those of permanent teeth. As a result, the adhesion energies of the two major cariogenic bacteria (Streptococcus mutans and Streptococcus sanguinis) to primary teeth are up to 10 and 5.5 times higher, respectively, than those to permanent teeth. This reveals, at the molecular scale, the interfacial energy mechanism underlying the high caries susceptibility of primary teeth, providing a clear direction for precision caries prevention: modulating tooth surface interfacial energy and microenvironmental pH.

Based on this finding, we constructed an intelligent perception–active response multifunctional molecular layer for caries microenvironment regulation using peptide–polymer conjugates, pH-sensitive block copolymers, and related materials. The polymer coating reduces the polar force and total interfacial energy of the tooth surface and forms a physical barrier through restricted bound water between molecular chains, decreasing the adhesion energy of cariogenic bacteria by 91%. pH-responsive groups sense the acidic microenvironment, achieving a bacterial killing rate exceeding 95% within 10 minutes, while causing minimal damage to beneficial oral flora. When the local pH recovers, the material automatically initiates remineralization, with a demineralized tissue repair efficiency of 1.3 times.

22 INVITED

## Single-atom Catalyst Initiates Acute Lung Injury Immunotherapy by Inhibiting Macrophage Pyroptosis

单原子催化剂通过抑制巨噬细胞热解启动急性肺损伤免疫治疗

**Xiangyu Lu 逯向雨**

*Tongji University, China · 助理教授*

Acute lung injury (ALI), with mortality approaching 40%, lacks effective therapies. Macrophage pyroptosis represents a key pro-inflammatory event and promising therapeutic target. Here, we report a single-atom immunomodulator, potassium single-atom catalyst (K-SAC) with K-N4 sites, that suppresses macrophage pyroptosis for ALI therapy through antioxidant catalysis. Using biocompatible potassium, the most abundant intracellular metal in humans, K-SACs display potent superoxide dismutase- and catalase-like activities, with the underlying mechanisms revealed by DFT simulations. Following preferential macrophage uptake, K-SACs scavenge reactive oxygen species (ROS), downregulate gasdermin D (GSDMD) and its N-terminal fragment (GSDMD-NT), activate endosomal sorting complexes

required for transport (ESCRT)-mediated membrane repair, and promote membrane phospholipid remodeling, thereby effectively inhibiting macrophage pyroptosis. Notably, this catalytic membrane repair mechanism offers a versatile strategy for actively restoring membrane integrity. Such catalytic inhibition of pyroptosis preserves pulmonary immune homeostasis and ameliorates lipopolysaccharide (LPS)- or cecal ligation and puncture (CLP)-induced ALI, establishing a catalytic immunotherapeutic paradigm.

**23 KEYNOTE**

## Intelligent Nanorobots for One Health

**Martin Pumera**

*Brno University of Technology, Czech Republic*

*Abstract not received at the time of printing.*

**24 KEYNOTE**

## Title to be announced

**Francesca Santoro**

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*Abstract not received at the time of printing.*

**25 KEYNOTE**

## Probing Function with Designing Structure: Instructive Scaffolds for Intelligently Manufactured Tissue Regeneration

**Lorenzo Moroni**

*Maastricht University, Netherlands*

Organs are complex systems, comprised of different tissues, proteins, and cells, which communicate to orchestrate a myriad of functions in our bodies. Technologies are needed to replicate these structures towards the development of new therapies for tissue and organ repair, as well as for 3D in vitro models to better understand the morphogenetic biological processes that drive organogenesis. To regenerate tissues and organs, biofabrication strategies are being developed to impart spatiotemporal control over cell-cell and cell-extracellular matrix communication, often through control over cell and material deposition and placement. This passes often through the fabrication of a scaffold, whether a cell-laden hydrogel construct or an acellular 3D porous network. Scaffolds for regenerative medicine applications have been historically produced by the adoption of industrial manufacturing technologies, such as textile, moulding, and foaming. With the advent of additive manufacturing (AM), it has been possible to design scaffold geometry and structure. AM not only enabled the design of architected porous biomaterials with anatomical customization, but also of smart cell-material interfaces able to instruct cell activity and steer tissue regeneration. More recently, the integration of computational and machine-learning-assisted design methods with AM has begun to extend this control towards the data-driven optimization of scaffold topology and composition. Here, we introduce several examples of instructive, intelligently designed scaffolds aimed at steering functional tissue regeneration. To achieve these targets, the spatiotemporal control over biological signals at the interface between cells and materials is often aimed for. Alternatively, biological activity can be triggered through the control of mechanical cues, harnessing more fundamental know-how in mechanobiology that could be combined with biofabrication strategies. Some of the most recent advancements in merging surface functionalization, mechanobiology, and AI-assisted design with biofabrication that enabled the control of cell activity are presented, moving towards enhanced, intelligently engineered tissue regeneration.

26 KEYNOTE

## Artificial Intelligence-Guided Nano Co-Assembly for Next-Generation Drug Delivery

**Helder Santos**

*University Medical Center Groningen, Netherlands*

Recent advances in artificial intelligence are transforming the discovery and development of nanomedicines. In this presentation, we will discuss how machine learning and explainable AI can be integrated with physicochemical characterization and biological evaluation to accelerate the design of self-assembled drug delivery systems. Drawing on our recent studies, including machine learning-informed nano co-assembly inhibits fibroblast activation protein and improves drug delivery in fibrotic tissue, and complementary work on AI-enabled analysis of molecular determinants governing nanomedicine assembly. We demonstrate how computational approaches can identify key molecular features controlling nanoparticle formation, colloidal stability, drug loading and biological performance. Screening of large molecular datasets combined with explainable machine learning revealed interpretable design rules linking aromaticity, molecular rigidity and nitrogen-mediated interactions to successful nano co-assembly. These insights enabled the development of stable self-assembled nanoparticles with improved drug delivery in challenging fibrotic microenvironments. The work highlights how AI can move nanomedicine development from empirical optimization toward predictive and mechanistically informed design, creating new opportunities for precision drug delivery and advanced biomedical materials.

27 INVITED

## Interface catalysis induced by contact electrification effect and its application

**Peng Jiang**

*Wuhan University, China*

*Abstract not received at the time of printing.*

28 INVITED

## Multidimensional Remodeling of the Tumor Microenvironment Mediated by Immune-Modulating Probes

免疫调节探针介导肿瘤微环境的多维重塑

**Shuren Wang**

*Sun Yat-sen University, China*

Conventional tumor immunotherapy faces the challenges of single targets and low response rates due to the complexity and heterogeneity of the tumor microenvironment (TME). Therefore, based on the unique physical and biological characteristics of the TME, this study constructed a series of smart magnetic theranostic platforms with immunomodulatory functions, aiming to remodel the TME from multiple dimensions.

In terms of breaking down physical barriers, probes targeting cancer-associated fibroblasts (CAFs) were designed to disrupt the dense stromal barrier constructed by CAFs, achieving precise enrichment and deep penetration of the probes at the tumor site, while reversing CAF-mediated immunosuppression. Their favorable antitumor efficacy and clinical translation potential were validated in both primary and humanized colorectal cancer models. In terms of immune microenvironment remodeling, a temperature/pH dual-responsive immunomodulatory nanozyme was constructed to achieve controlled release of the immune agonist R848, effectively activating dendritic cells, enhancing CD8+ T cell function, and reducing the proportion of myeloid-derived suppressor cells, thereby improving the immunosuppressive microenvironment; the underlying molecular mechanism of enhanced apoptotic signaling was also elucidated. In terms of catalytic-immune synergistic enhancement, a novel catalytic immunotherapy strategy based on Au-Fe/$Fe_3O_4$ was proposed, which promoted dendritic cell maturation and drove tumor-associated macrophages toward M1 polarization, successfully converting “cold” tumors into “hot” tumors and providing a new paradigm for immunotherapy of triple-negative breast cancer.

In summary, this study established a systematic multi-dimensional TME remodeling strategy spanning physical barrier disruption, immune microenvironment reprogramming, and catalytic synergistic therapy, offering new insights for overcoming the bottlenecks of tumor immunotherapy.

**29 INVITED**

## Nanoenzymes as a new generation of antibacterial agents: from construction to application in anti-infective therapy

**Xiaojun He**

*Peking University First Hospital, China*

The increasing severity of bacterial resistance urgently requires the development of new antibacterial strategies. Nanoenzymes, as a new generation of antibacterial agents, possess both nanomaterial properties and enzyme like catalytic activity, and can achieve efficient sterilization by regulating the level of reactive oxygen species. Our team has been committed to the design and anti infection application of inorganic organic hybrid nanomaterials for a long time. We have constructed a series of multi metal nanoenzymes, single atom nanoenzymes, and high entropy MXene nanoplatforms. Through NIR-II photothermal enhancement synergy, sonodynamic therapy, and cascade catalysis, we have achieved efficient removal of methicillin-resistant bacteria such as Staphylococcus aureus, and successfully applied them to bacterial keratitis, osteomyelitis, and infectious wound repair, providing theoretical and experimental basis for the transformation and application of nanoenzymes in the field of anti-infection treatment.

**30 INVITED**

## Precision Design and Functional Regulation of Nucleic Acid-Based Biomedical Materials

核酸基生物医学材料的精密设计与功能调控

**Yu Yang**

*Shanghai Jiao Tong University School of Medicine, China*

The performance of biomedical materials in complex physiological environments depends on biodistribution, tissue delivery, cellular uptake, and accessibility to their sites of action. Translating diagnostic and therapeutic requirements into controllable molecular structural parameters and establishing structure–function relationships are central challenges in developing nucleic acid-based biomedical materials. Nucleic acids offer programmable sequences, site-specific modification, and tunable spatial architectures. Defined sequences and folded structures can also enable target recognition, gene silencing, and stimulus responsiveness, providing a molecular basis for integrating material construction with biological activity.

This presentation highlights strategies and advances in the precision design and functional regulation of nucleic acid-based biomedical materials, focusing on carrier architecture, the spatial organization of recognition elements, and stimulus-responsive mechanisms to control delivery, target recognition, and protein fate. To address tumor immune evasion, we have developed functional nucleic acid-based strategies that couple molecular recognition with conditional activation to regulate target protein trafficking and degradation, extending the scope of conventional immune checkpoint blockade. We further extend this approach to tumor cell-intrinsic immune evasion networks. Through in vivo CRISPR–Cas9 functional screening, we identified STK40 as a regulator of immune evasion and elucidated mechanisms through which it influences tumor cell susceptibility to T cell-mediated killing and antitumor immune activation. Building on these findings, we developed lipid nanoparticle-formulated siRNA targeting STK40 and evaluated its therapeutic effects in patient-derived tumor organoids and humanized tumor models.

Together, these studies integrate nucleic acid material design with target discovery, mechanistic investigation, and functional validation. By exploring complementary approaches based on cell-surface target protein degradation and intracellular gene silencing, this work provides a foundation for developing structurally defined, functionally tunable nucleic acid-based biomedical materials and therapeutic strategies targeting tumor immune evasion.

31 INVITED

## Hydrogel wearable electronic devices for human electrocardiogram monitoring

用于人体心电图监测的水凝胶可穿戴电子设备

**Lin Qiu**

*University of Science and Technology Beijing, China*

Long-term wearable electrocardiogram (ECG) monitoring requires electrodes that combine mechanical robustness, conformal skin contact, and stable electrical conduction. Here, a multifunctional conductive hydrogel was developed as a candidate material for flexible ECG electrodes. The hydrogel was fabricated using a two-step strategy combining in situ polymerization with post-treatment in a calcium-containing glycerol/water solution. Its structure and properties were evaluated through microscopic and chemical characterization, tensile and cyclic loading tests, electrochemical impedance spectroscopy, and adhesion tests. The material design integrates a covalently crosslinked polymer framework with dynamic physical interactions and ion-mediated coordination, aiming to improve mechanical integrity without sacrificing interfacial conformity. A dispersed conductive nanofiller network and mobile ions provide complementary electronic and ionic transport pathways, while the mixed-solvent system is designed to enhance moisture retention and environmental adaptability. The results show that both composition and ionic crosslinking conditions affect the hydrogel's mechanical response and electrical conductivity. The hydrogel also demonstrates self-adhesion to skin and various substrate surfaces, supporting its potential for skin-interfaced applications. This work proposes a multinetwork design strategy for balancing mechanical robustness, skin adhesion, and charge transport, and provides an experimental foundation for the development of flexible hydrogel electrodes for wearable ECG monitoring.

32 INVITED

## Sub-femtonewton force sensing and super-resolved temperature measuring

亚飞秒力传感与超分辨温度测量

**Fan Wang**

*Beihang University, China*

Optical tweezers face challenges in trapping low-refractive-index nanoparticles and detecting weak forces. Here, we introduce lanthanide-doped upconversion nanoparticles (UCNPs) that leverage nonlinear photoresponse and ion resonance to amplify optical forces, bypassing refractive-index limitations. Resonance-enhanced trapping of NaYF4 nanocrystals yields a record stiffness of 0.086 pN $\mu m^{-1}$ $mW^{-1}$, which is 30× stronger than gold nanoparticles of similar size, thereby enabling nanoscale manipulation and integration with temperature sensing. For ultrasensitive force detection, we developed a super-resolved photonic force microscope combining UCNPs with neural-network-enhanced 3D tracking. This achieves thermal-limit sensitivity (1.8 fN Hz-1/2) and attoNewton-level (aN) resolution, probing electrophoresis and surface forces at the single-particle level. Additionally, a multilayer microprobe attains 14.24 pN $\mu m^{-1}$ $mW^{-1}$ trap stiffness, tripling prior benchmarks. It measures mitotic HeLa cell elasticity, demonstrating nanonewton biomechanical sensing. These advances bridge material innovation and machine learning, enabling unprecedented studies of nanoscale forces, cellular mechanics, and sub-fN interactions.

33 INVITED

## Immunological activation of albumin@porous silicon nanocomposites on innate immunity for cancer immunotherapy

Albumin@porous 硅纳米复合材料对癌症免疫治疗的先天免疫作用

**Bing Xia**

*Nanjing Forestry University, China*

Porous silicon nanoparticles have enormous application in biomedical fields, such as cell imaging, tumor imaging, biosensing, and drug carriers, due to their unique fluorescence, nanoporous structures, biodegradability, and good biocompatibility. And bovine serum or human serum albumin is certified by the US Food and Drug Administration

(FDA), with excellent biocompatibility and biodegradability, which contains rich functional groups such as carboxyl and amino groups for versatile functionalization and modification. Albumin can also utilize its own lymph node reflux mechanism to achieve active targeted delivery to lymph nodes, further enhancing the immune stimulation effect of adjuvants. In addition, albumin can be efficiently adsorbed onto the hydrophobic surface of porous silicon nanoparticles through hydrophobic effects, forming albumin @ porous silicon nanocomposites. This type of nanocomposite can be efficiently uptake by innate immune cells, activate innate immune response, and further improve the efficiency of anti-tumor immune response. It is expected to be applied as an immune adjuvant in cancer immunotherapy.

**34 INVITED**

## Osteoporosis Treatment via Programmed Delivery of IRF5 siRNA to Macrophages in Bone Tissue Combined with ROS Scavenging

通过程序化递送 IRF5 siRNA 治疗骨质疏松症骨组织巨噬细胞联合 ROS 清除

**Yuting Niu**

*Peking University, China*

Estrogen deficiency induces oxidative stress and M1 macrophage polarization in bone tissue, leading to sustained osteoclast activation and resulting in postmenopausal osteoporosis (PO). Interferon regulatory factor 5 (IRF5) is a key regulator of M1 polarization, and silencing its gene using small interfering RNA (siIRF5) is expected to alleviate the onset and progression of PO. However, how to selectively deliver siIRF5 to M1 macrophages in the PO microenvironment remains a challenge. This study aimed to construct a programmed sequentially targeted nanomedicine, siP@WM, that targets M1 macrophages in bone tissue, and to synergistically treat PO through ROS scavenging and IRF5 gene silencing.

**35 INVITED**

## Design and Health Monitoring Application of Polyvinylidene Fluoride Flexible Piezoelectric Sensing System

聚偏二氟乙烯基柔性压电传感系统设计及健康监测应用

**Yuanzheng Zhang**

*Henan University, China*

Wearable pressure sensors provide support for technologies such as intelligent action recognition and physiological signal sensing. Traditional pressure sensing devices have limitations such as rigidity and low level of intelligence. This report proposes an innovative solution based on PVDF based flexible piezoelectric sensing system to address the core issues of system construction and implementation in specific application scenarios in wearable pressure sensing systems. By designing a wearable AI cluster for action recognition, strong anti-interference ability and multi joint participation in action perception have been achieved, with a certain degree of assembly freedom. At the same time, a closed-loop wearable system integrating diagnosis and treatment has been designed, effectively solving the problems of difficult biological pulse perception and single sensing system functions, and fully verifying the effectiveness of the system's diagnosis and treatment integration. The research results provide a practical example for PVDF based flexible pressure sensing systems and their application in the field of health monitoring, which can promote the widespread application of wearable pressure sensing technology and lay the foundation for the intelligence of future flexible sensing systems. The research focuses on the core issues of implementing action recognition devices and constructing integrated diagnostic and therapeutic devices in wearable pressure sensing systems. Innovative solutions have been proposed in different application scenarios, which are expected to build a more complete wearable sensing system.

36 ORAL

## A wireless closed-Loop vagus nerve stimulation platform for rapid antidepressant neuromodulation

**Jian Chen**

*Fudan University, China*

*Abstract not received at the time of printing.*

37 ORAL

## Targeted Intervention of Tumor Metabolic Vulnerabilities Using Metal-Based Nanomaterials

**Ran Ma**

*Peking University, China*

*Abstract not received at the time of printing.*

# 分论坛五

SYMPOSIUM 05 · NEW ENERGY MATERIALS AND GREEN MANUFACTURING

新能源材料与绿色制造

05

AI EMPOWERMENT · MATERIALS INNOVATION · INTELLIGENT MANUFACTURING

01 KEYNOTE

## Electrode–Electrolyte Design and Operando Insights for Safe, Durable, and High-Energy Batteries

**Shuhui Sun 孙书会**

*Institut National de la Recherche Scientifique (INRS), Canada · Professor*

The lithium metal anode is widely regarded as the “holy grail” electrode due to its exceptionally high theoretical capacity, approximately ten times that of graphite anodes in conventional Li-ion batteries. However, the commercialization of lithium metal batteries has been severely hindered by the formation of lithium dendrites. These dendrites degrade electrochemical performance, shorten battery lifespan, and may penetrate the separator, potentially causing internal short circuits and, in extreme cases, thermal runaway and fire hazards.

To address this challenge, we have developed effective electrolyte additive strategies that suppress dendrite growth during battery operation. Our approach is simple, low-cost, and, importantly, fully compatible with existing battery manufacturing processes, offering strong potential for practical implementation. Through a combination of advanced microscopy, synchrotron-based X-ray absorption spectroscopy (XAS), and computational modeling, we reveal that small amounts of additives can induce unique interfacial chemistry at the lithium/electrolyte interface, enabling stable and uniform lithium deposition.

Beyond improving lithium-based systems, the development of alternative battery chemistries (e.g., Zn and Al batteries) is critical for achieving sustainable and resource-efficient energy storage. In this context, we will present representative studies employing in situ/operando synchrotron techniques, including XAS and scanning transmission X-ray microscopy (STXM), along with advanced imaging methods to elucidate material evolution and dendrite formation, and to guide the design of next-generation batteries.

02 KEYNOTE

## Making Robust Aqueous Zinc Batteries

**Hongjin Fan 范红金**

*Nanyang Technological University, Singapore · Professor*

Rechargeable aqueous batteries are being widely studied for their potential application in static energy storage as a high-safety alternative to the current lithium-based batteries. Our group has been working holistically on anodes, cathodes, and electrolytes to boost the durability and capacity of metal aqueous systems (e.g., Zn, Mg, Sn) towards practical batteries. This talk will focus on aqueous zinc-iodine batteries and showcase our strategies in designing multimodal electrolytes, hydrogels high-iodine loading, and multi-electron reactions. Our perspective towards practical ampere-hour level ZIBs will be demonstrated.

03 KEYNOTE

## 2D Metal Oxide Nanostructures for Sustainable Energy Technologies

**Ziqi Sun**

*Queensland University of Technology, Australia · Professor*

Sustainable energy has been regarded as one promising alternative to displace current fossil energy resources by its high energy value and zero CO2 emission to address the increasing environment and energy crises. Especially, electrochemical energy systems are expected to be the most feasible approach with a good balance of cost and efficiency, in which nanostructured electrodes are the most critical component and govern the conversion cost and energy efficiency. Therefore, the research on affordable electrode materials and structures with comparable performance to replace with the current traditional energy technologies is an urgent priority. In this presentation, inspired by the salient properties of 2D materials, promising 2D metal oxide-based nanostructures for electrochemical energy devices through mechanism understandings and performance upgrades will be presented. It is expected that

this presentation will provide some insights into designing low-cost but efficient energy materials for reaching affordable and reliable sustainable energy technologies.

04 KEYNOTE

## Reversible Solid Oxide Cell for Integrated Energy Storage and Power Generation

"储能+发电"一体化的可逆固体氧化物燃料电池

**Zhipeng Li 李致朋**

*Northwestern Polytechnical University, China · 教授*

固体氧化物燃料电池（SOFC）可将燃料化学能直接转化为电能，发电效率达 50–60%，热电联供效率可超 80%，并适配天然气、甲醇、柴油及工业副产气等多种燃料。美、日等国已在无人机、潜艇、家用热电联供等领域实现工程应用，而我国在基础材料研究方面积淀深厚，但在电堆集成、系统开发及规模化制造方面仍存在差距，亟需突破自主化产品瓶颈。

可逆固体氧化物燃料电池（RSOC）在同一电池堆上实现了燃料电池（SOFC）发电模式与固体氧化物电解池（SOEC）储能模式的灵活切换：在电力富余时，将电能转化为氢或碳氢燃料进行储存；在用电高峰时，将储存燃料转化为电能回馈电网，从而实现"储能+发电"一体化。该技术为可再生能源消纳、电网调峰及分布式能源系统提供了高效、长时、大容量的解决方案。然而，RSOC 对电极材料提出了双功能要求——既要在氧化气氛中高效催化燃料氧化，又要在还原/电解气氛中稳定催化蒸汽/$CO_2$电解；同时，电池在频繁模式切换中面临界面失稳、相变、镍迁移及热循环疲劳等关键材料与寿命问题。本报告围绕 RSOC 的工作原理、关键材料（包括空气电极、燃料电极及电解质）的设计策略展开，分析电极微观结构演化、缺陷化学与衰减机理，探讨纳米化电极、梯度结构及界面工程等性能优化途径，为我国发展自主可控的 RSOC 储能-发电一体化技术提供参考。

05 KEYNOTE

## Design of Fiber Separators for High-Performance Aqueous Zinc-Ion Batteries

高性能水系锌离子电池的纤维隔膜设计

**Guanjie He 何冠杰**

*University College London, UK · 教授*

Aqueous zinc-ion batteries (AZIBs) have garnered widespread attention as a low-cost, safe, and sustainable alternative for large-scale energy storage. The separator is an important yet often overlooked aspect in the research of aqueous zinc-ion batteries. Membranes exhibit different permeation selectivity towards different ions, which affects the concentration gradient and potential difference during migration and diffusion, thereby influencing the electrochemical performance. Traditional glass fiber is the most common separator for aqueous zinc-ion batteries, but it currently faces three major issues: high thickness, high cost, and brittle structure, which pose significant obstacles to the commercialization of zinc-ion batteries. In this report, I will share our recent work on fiber separators for aqueous zinc-ion batteries, including separator modification and the design of new membrane structures, as well as some commercialization explorations in the design of large pouch cells. These research findings provide new insights into the design of seperator for constructing high-performance, long-cycling aqueous zinc-ion batteries.

06 KEYNOTE

## Aqueous Aluminum-ion Batteries

**Qingyu Yan 颜清宇**

*Nanyang Technological University, Singapore · Professor*

*Abstract not received at the time of printing.*

06 KEYNOTE

## Advanced Thermoelectric Cooling Materials

**Lidong Zhao 赵立东**

*Beihang University, China · 教授*

Thermoelectric cooling is a solid-state cooling technology that utilizes the Peltier effect in semiconductor materials to achieve cooling through the direct conversion of electrical energy into thermal energy. Owing to its numerous advantages, including precise temperature control, flexible dimensions, diverse structural configurations, and localized cooling capabilities, thermoelectric cooling technology exhibits strong competitiveness and considerable application potential in critical fields such as microelectronics, sensors, 5G optical modules, and laser weapons. Currently, bismuth telluride (Bi2Te3)-based materials remain the only thermoelectric cooling materials suitable for widespread practical applications. However, Te is as scarce as platinum in the Earth's crust, and CdTe-based photovoltaic technologies are expected to account for approximately half of the tellurium market. Furthermore, Bi2Te3-based materials and thermoelectric cooling devices suffer from several limitations, including poor processability, insufficient cooling performance, and excessive operating power consumption. Therefore, materials research remains at the core of advancing thermoelectric cooling technology, making the exploration and development of novel thermoelectric cooling materials and devices critically important. Recent studies have demonstrated that SnSe-based thermoelectric materials, developed based on the wide-bandgap design principle, exhibit remarkable thermoelectric characteristics, including strong lattice anharmonicity, complex electronic band structures, and three-dimensional charge transport coupled with two-dimensional phonon transport. These unique features enable SnSe to achieve superior thermoelectric performance near room temperature compared with conventional Bi2Te3-based materials. Furthermore, by introducing a novel “grid-plainification” strategy to regulate intrinsic defects in SnSe crystals and enhance carrier mobility, the room-temperature thermoelectric performance of SnSe has been further optimized, enabling highly efficient solid-state cooling.

07 INVITED

## Ni/Co Based Catalysis for Sulfur Cathodes in Wide-temperature-range Sodium–Sulfur Batteries

**Wei Zhou 周苇**

*Beihang University, China*

*Abstract not received at the time of printing.*

08 INVITED

## Composite Solid Electrolytes for Solid-State Li Metal Batteries

**Jie Zhao 赵婕**

*Fudan University, China*

The rapid development of global electric aviation, deep-sea submersibles, space stations and other high-tech fields has created an urgent demand for solid-state batteries with high safety and high energy density. The issues of Li dendrites and poor mechanical compatibility with electrodes present the need for developing solid-state electrolytes with high stiffness and damping, but it is a contradictory relationship. Inspired by the superstructure of tooth enamel, we develop a composite solid-state electrolyte composed of amorphous ceramic nanotube arrays intertwined with solid polymer electrolytes. This bionic electrolyte exhibits both high stiffness (Young’s modulus=15 GPa, hardness=0.13 GPa) and damping (tanδ=0.08), breaking the trade-off. Thus, this composite electrolyte can not only inhibit Li dendrites growth but also ensure intimate contact with electrodes. We further develop an in situ polymerized hetero-layered electrolyte that simultaneously broadens the electrochemical window and addresses interfacial issues between multiple components. These improvements have enabled the development of high-voltage lithium-metal solid-state batteries.

09 INVITED

## Research on Electrode/Electrolyte Design and Ion Interfacial Transport Mechanisms for High-Safety Energy Storage Batteries

高安全储能电池电极/电解液设计及界面传输机制研究

**Huajun Tian 田华军**

*North China Electric Power University, China · 教授*

高安全储能电池关键电极材料/电解液因固有安全、环境友好和低成本等优势，在海水锌电池、盐湖水锌电池等储能方向具有较佳应用前景。水系锌电池的锌金属负极具备较低氧化还原电势、较高理论容量和可回收等优点，令其更具竞争力。但水系锌电池仍有若干技术瓶颈待解：（1）充/放电时，锌负极表面电场不均与锌离子无约束二维扩散，诱发锌沉积不匀并生成枝晶。枝晶易穿透隔膜引发内短路，也会导致电极形变和失活。（2）锌负极在水系电解液中易自发腐蚀与电化学蚀损，并伴随析氢副反应；密封电池内氢气积聚推高内部气压，造成电池鼓胀破裂和电解液渗漏。（3）在单体层级，关键材料匹配协同、单体制造及离子输运机理仍缺系统探究，限制高安全长寿命水系锌电池发展。所以，破解上述难题是实现其产业化的关键。。

本团队围绕高安全海水锌电池、盐湖水锌电池关键电极材料/电解液设计、电芯试制及离子传输机制开展系统研究[1-5]。团队通过低成本、快速合成技术制备了系列具有功能表面结构的三维锌基合金界面材料和正极材料，优化后的三维结构有利于高效调控锌沉积/溶解反应动力学，抑制枝晶形成。系统探讨了单阳离子和双阳离子水系电解液体系中锌的沉积/溶解机制，并借助原位光学显微镜在低电流密度至 80 mA $cm^{-2}$下实时观测形貌演变，证实锌优先沉积于三维合金结构内部，阐明了三维结构对锌离子传输路径和成核位点的调控机制。该工作为稳定电极/电解液界面、高安全长循环海水锌电池、盐湖水锌电池电芯试制及实用化提供了有效策略和参考。

10 ORAL

## Low-Temperature Sodium Storage in O3-Type Layered Oxide Cathodes Enabled by Nb Doping-Induced Structural Stabilization and $Na^+$ Kinetics Optimization

**Xinnan Zhang 张歆楠**

*Taiyuan University of Technology, China*

*Abstract not received at the time of printing.*

11 KEYNOTE

## Low Carbon Processes for Efficient Manufacturing of Battery Materials

**Deepak Dubal**

*Queensland University of Technology, Australia · Professor*

The widespread adoption of electric vehicles has spurred the utilization of lithium-ion batteries (LIBs), intensifying the substantial demand for battery materials, particularly high-energy cathode materials. Traditional methods for heating in cathode production have typically involved conventional furnaces or solvothermal reactors. This conventional approach results in extended reaction times, high energy consumption, and a significant contribution to CO2 emissions. Furthermore, extensive research has demonstrated that the structure and texture of electrode materials are strongly influenced by factors such as heat treatment temperature, heating/cooling rates, duration, and environmental conditions. Within our research group, we are actively working on the development of innovative rapid heating techniques for battery material preparation. These newly synthesized materials have exhibited exceptional electrochemical properties. These promising outcomes open the path toward the production of other oxide materials for energy storage and various applications by employing these advanced heating techniques.

12 KEYNOTE

## Physics-Aware Digital Twins & Human-in-the-Loop Battery Manufacturing

**Alejandro A. Franco**

*Université de Picardie Jules Verne, France, Distinguished Full Professor*

The rapid scale-up of battery gigafactories requires unprecedented agility across both traditional wet slurry and emerging dry electrode processing. In this talk, I review our digital twin frameworks—pioneered by my group over 13 years ago—leveraging physics-aware AI to optimize battery manufacturing from powder to cell. By grounding machine learning in fundamental multiphysics, these models can accurately predict and inversely design battery electrode architectures and cells. Crucially, I emphasize why fully autonomous systems fall short without "human-in-the-loop" strategies. By acting as a cognitive copilot, this synergy of physical modeling, AI, and human expertise empowers operators to make rapid, informed decisions, seamlessly bridging the physical-digital divide directly on the production line.

13 KEYNOTE

## Intelligent Ore Sorting Technology and Its Application in Lithium Mines

**Xianping Luo 罗仙平**

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*Abstract not received at the time of printing.*

14 KEYNOTE

## Defective Layered Double Hydroxide Based Nanostructured Photocatalysts for $N_2$ Fixation

**Tierui Zhang 张铁锐**

*Technical Institute of Physics and Chemistry, Chinese Academy of Sciences, China · 研究员*

*Abstract not received at the time of printing.*

15 KEYNOTE

## Barocaloric Effect: from Phase Transition to Dissolution

**Bing Li 李昺**

*Institute of Metal Research, Chinese Academy of Sciences, China · 研究员*

The barocaloric effect traditionally manifests as thermal responses during pressure-induced phase transitions of solids, governed by either disorder-to-order mechanisms or phonon-renormalization processes [1]. Exemplifying the former, pressure-induced orientational disorder-to-order transitions in plastic crystals produce colossal barocaloric effects [2], achieving milestone entropy changes of several hundred J $kg^{-1}$ $K^{-1}$. Recently, we extended classical caloric effects beyond solid-state systems by introducing dissolution barocaloric effects in aqueous NH4SCN solutions, where pressure-induced precipitation drives the thermal response [3]. This breakthrough enables the simultaneous achievement of previously mutually exclusive refrigeration merits: large cooling capacity, low carbon emissions, and efficient heat transfer. Consequently, this dissolution-based approach integrates the advantages of conventional vapor-compression refrigeration with those of solid-state caloric cooling, representing a paradigm shift from phase-transition-based to dissolution-based barocaloric systems. This evolution opens new avenues for sustainable and efficient refrigeration technologies.

16 INVITED

## Design and Fabrication of Energy Materials via Spin Regulation

基于自旋调控的能源材料创制

**Han Hu 胡涵**

*China University of Petroleum (East China), China*

团队聚焦能源材料中缺陷、单原子中心及表界面等关键活性位点，针对其定量分析难、工况下结构特征获取难等瓶颈，构建以电子顺磁共振（EPR）为核心的可定量、高保真表征方法体系：针对能源材料自旋特性定量误差大、原位测试难等瓶颈，构建了多款适配性 EPR 毛细管，实现了对能源材料自旋特性的定量及原位测量；揭示了赝电容电极、电解水催化剂等材料自旋状态与电化学活性的内在关联，深化了对电化学微观作用机制的认识；提出了活性中心非对称配位诱导的自旋调控策略，初步搭建了自旋特性调控数据库，创制了高性能氧还原催化剂和电解水催化剂。

17 INVITED

## The Magnetoelectric Regulation Concept of Ultra-thin Broadband Electromagnetic Wave Absorbing Materials

**Zhenhui Ma 马振辉**

*Beijing Technology and Business University, China*

Electromagnetic wave absorbing materials have wide applications in consumer electronics, stealth weapons, anechoic chambers and other fields. Magnetoelectric composites, capable of simultaneously absorbing magnetic and electric components of electromagnetic waves, represent a class of highly promising wave-absorbing materials. Nevertheless, precise regulation of magnetic and dielectric properties remains a critical scientific challenge in this research area.

To address this issue, this work achieves precise modulation of materials from both magnetic and electric perspectives, and ultimately develops ultra-thin broadband electromagnetic wave absorbers.

In terms of magnetic property regulation, we propose a novel concept of surface magnetic moment for the first time. The concept states that when electromagnetic waves interact with materials, the magnetic moments on the surface of magnetic materials dominate the response, while the contribution from bulk magnetic moments is relatively weak. By tuning the dimension of ferrite materials, the quantity of surface magnetic moments is modulated, and the vital role of surface magnetic moments is verified. This conclusion is further validated by designing hollow-structured ferrites.

For dielectric regulation, our team pioneers the concept of electron migration polarization. Taking magnetic core@graphene core-shell structures as the research model, rare-earth nanomaterials are introduced onto the graphene shell layer to restrain long-range electron transport and break the conductive network formed by magnetic particles, thereby avoiding the skin effect. Biphasic rare-earth particles and rare-earth-transition metal nanoparticles with electronegativity differences are constructed to enable short-range electron transfer between particles, which enhances dielectric polarization loss. Efficient electromagnetic wave absorption is thus realized at an ultra-thin thickness.

18 INVITED

## Interfacial Electron Transfer Model

**Long Kong 孔龙**

*Northwestern Polytechnical University, China · 教授*

Graphite lithiation is fundamentally electron-driven, yet conventional kinetic models emphasize ion migration and $Li^+$ desolvation. This work establishes the interfacial electron transfer (IET) model as a hidden kinetic regulator of graphite lithiation. Because interfacial electron transfer occurs on a femtosecond timescale ($10^{-15}$ s), whereas solvation-shell reorganization and ion migration occur on picosecond-to-nanosecond timescales ($10^{-12}$–$10^{-9}$ s), the processes are non-concerted: electrons respond instantaneously to potential while solvated $Li^+$ remains momentarily stationary. This transient IET pre-polarizes the interface and lowers the activation barrier for the subsequent rate-

determining $Li^+$ desolvation step. Compared with neutral solvents, anions have higher charge density and elevated frontier orbital levels, giving stronger electron-transfer propensity. Modulating anion participation in the $Li^+$ solvation sheath converts graphite into an electron-rich state, weakens $Li^+$–solvent interactions, and reduces the Li de-coordination barrier. First-principles calculations show that increasing anion coordination shifts the graphite density of states toward lower energy and promotes electron accumulation, facilitating carbon intermediates. The apparent electron transfer propensity (AETP) descriptor links microscopic solvation speciation with macroscopic kinetics by weighting net electron transfer of each solvation motif by its electrolyte fraction. High-AETP electrolytes, represented by FSI-based systems, delay the Li plating plateau, reduce plating capacity, lower nucleation overpotential, and improve Coulombic efficiency and cycling stability under fast charging, whereas $PF_6$-based systems show lower AETP. The model thus shifts the kinetic paradigm from ion stripping to electron-guided de-solvation and provides a quantitative criterion for electrolyte and interface design in high-power lithium-ion batteries.

**19** INVITED

## Cyclable Micron-sized Elemental Electrode Materials-based Low-temperature Alkali Metal Batteries

**Dandan Yu 于丹丹**

*China Jiliang University, China*

*Abstract not received at the time of printing.*

**20** INVITED

## Preparation of Key Electrode Materials for Novel Potassium-Based Energy Storage

新型钾基储能技术关键电极材料制备

**Shuoqing Zhao 赵硕卿**

*Jilin University, China · 研究员*

*Abstract not received at the time of printing.*

**21** ORAL

## Material and Interface Design for High-Energy-Density All-Solid-State Lithium Metal Batteries

**Yijie Liu 刘一杰**

*Nanjing University, China*

All-solid-state lithium metal batteries offer a promising route toward high-energy storage with improved safety. However, their performance remains limited by stripping-induced interfacial void formation, grain-boundary instability in solid electrolytes, and insufficient reversibility of high-energy cathode reactions. This presentation highlights advances in materials design and interfacial stabilization across lithium metal anodes, solid electrolytes, and halogen-based cathodes. To address interfacial contact loss during lithium stripping, we introduce void-suppressive capability (VSC) as a descriptor linking lithium transport kinetics to interfacial void evolution. Grain refinement promotes rapid lithium transport, thereby mitigating void formation and improving interfacial stability (Nat. Mater. (2026) https://doi.org/10.1038/s41563-026-02729-w). For garnet solid electrolytes, we construct lithiophobic and mechanically tough grain-boundary interphases through an in situ approach. These interphases suppress lithium deposition at grain boundaries and crack propagation while enhancing mechanical integrity and electrode–electrolyte contact, supporting thin electrolyte membranes and high-areal-capacity all-solid-state cells (Nat. Nanotechnol. 21, 1288–1296 (2026)). To advance high-energy cathodes, we employ multihalogen intermediates to regulate high-voltage conversion pathways and improve the reversibility of fluorine-based electrode reactions, while exploring halogen-mediated sulfur redox chemistry involving positive oxidation states (Nat. Mater. (2026) accepted). Together, these studies provide complementary materials and interface design principles spanning anode transport kinetics, grain-

boundary chemistry and mechanics, and cathode reaction pathways for high-energy all-solid-state lithium metal batteries.

22 KEYNOTE

## Unlocking the Synergy of External Fields for Enhanced Electrocatalysis and Photoreforming

**Zhiqun Lin 林志群**

*National University of Singapore, Singapore, Provost's Chair Professor*

The ability to create highly efficient and stable catalysts represents important endeavors toward accelerating sluggish water-oxidation kinetics for green hydrogen production and photoreforming plastic waste into value-adding products. In this talk, I will discuss the unravelling of photothermal and synergy of magnetic field and chiral-induced spin selectivity (CISS) effect to promote oxygen evolution reaction activity. Subsequently, I will introduce a robust strategy that leverages CISS, ferroelectricity, and photocatalytic heterostructures to significantly improve charge carrier dynamics, offering a promising pathway for plastic photoreforming into value-added products.

23 KEYNOTE

## Diamond Materials for Electrochemical Energy Applications

**Nianjun Yang 杨年俊**

*Hasselt University, Belgium · Professor*

Conductive diamond and their composites are promising electrode materials as well as the substrates to load stable catalysts, stemming from its unique features, such as wide potential window, high stability in different solutions and under harsh conditions, tuneable surface terminations, rich surface chemistry, the possibility to form composites with other materials and high thermal conductivity. This presentation will summarize our activities over the design and characterization of conductive diamond and their composites as well as their employment for electrochemical energy storage and conversion applications. The fabrication and performance of several diamond supercapacitors will be highlighted. The future research directions of diamond materials for various electrochemical applications will be also discussed and outlined.

24 KEYNOTE

## Defective Carbon-based Materials for Electrocatalysis

**Jun Chen 陈俊**

*University of Wollongong, Australia · Chair Professor / Director of AIIM*

In the past decades, tremendous efforts have been devoted to developing carbon-based materials to reduce the need for precious metals in the field of electrocatalysis. Thereinto, defective carbon-based electrocatalysts have recently been considered one of the most promising alternatives owing to their irreplaceable advantages, such as environmentally friendly, low cost, and high structural tunability. However, despite remarkable progress has been achieved, grand challenges of their further development remain with the traditional "trial-and-error" approaches, mainly due to the lack of precise synthetic methodologies as well as in-depth understandings of active centres and underlying electrocatalytic mechanisms. Herein, we report some new synthetic strategies to precisely control the carbon defect density or manipulate the targeted migration of metal species on defective carbon substrate, which not only successfully realize the monitoring the structural dynamic evolution of DCMs, but also improve the fundamental understanding of the synthetic and electrocatalytic mechanisms. We believe that the development of synthetic methodologies of DCMs provides plenty of room for expanding the "gene pool" of electrocatalysts and then pushing the DCMs towards industrialization.

25 KEYNOTE

## Reimagining Energy Harvesting Materials – Green Synthesis and Manufacturing from Thermoelectric to Piezoelectric Materials & Devices

**Peter C. Sherrell**

*RMIT University, Australia, Senior Vice-Chancellor's Research Fellow*

Energy harvesting materials are experiencing a resurgence, from indoor solar cells to thermoelectric devices to triboelectric nanogenerators. At their core, these devices recycle waste energy – meaning their input energy is low, and their output (by definition) must be even lower. Therefore, in order for these materials to have an impact on manufacturing, industry, and energy sectors – they must be manufactured and deployed at scale. Currently, this deployment is limited by research choices made in pursuit of the highest performance materials – using expensive and/or toxic precursors and solvents which impede scale-up from lab scale to pilot-plant and beyond. In this talk, I will focus on our lab scale developments in green synthesis and fabrication of thermoelectric, piezoelectric, and triboelectric energy harvesters, in particular Metal-Organic Framework based Thermoelectric Materials and Polymer-based Piezoelectric devices. These case-study shows how simple design choices in materials synthesis and manufacturing can unlock enhanced performance at a fraction of the cost compared to conventional, costly, and environmentally harmful precursors and solvents.

26 INVITED

## Customization of Mesoporous Energy Materials

**Zaiwang Zhao 赵再望**

*Inner Mongolia University, China*

Hierarchical mesoporous materials are vital in many fields such as catalysis and energy storages, but the precise synthesis remains a great challenge. Some typical works reported by our groups listed below: i) an ultra-stable single micelle was obtained via a thermodynamic method, and the ultra-small organic-inorganic nanohybrids (<50 nm) with good monodispersity and uniformity were synthesized, involving SiO2, TiO2, ZnO, Ag etc.; ii) various "earth-satellites" type superstructures were synthesized through a single-micelle based an interface super-assembly strategy. In this structure, single micelles were regularly arranged on the surface of the spherical SiO2 substrates in a quasi-ordered hexagonal manner. 3) mesoporous carbon superstructures with a monolayer of spherical mesopores (22 nm) on the surface of center hollow (300 nm) were synthesized by s facile monomicelle interface confined assembly strategy. At the same time, there was a small pore (4.0-4.5 nm) on the inner surface of each spherical mesopore, making it totally interconnected. This superparticle exhibited a high specific surface area (685 m2g-1) and excellent underwater hydrophilicity. In addition, the precise control of the number of mesopores (70-360) has been achieved for the first time, which is unachievable by the traditional methods. Finally, the efficient performance of this mesoporous supraparticle was demonstrated.

27 INVITED

## Precise Design of Local Structures in Catalysts for Water Electrolysis

电解水制氢用催化材料的局域结构精准设计

**Yao Zhou 周遥**

*Beijing Institute of Technology, China · 教授*

Electrochemical water splitting for hydrogen production is an environmentally benign route to high-purity hydrogen and holds significant implications for green hydrogen development under the "dual carbon" goals. Achieving low-cost, high-efficiency hydrogen production under practical operating conditions requires enhancing both the intrinsic activity and the service stability of electrocatalysts. Rational design of the local configuration of electrocatalysts is an effective means to improve the intrinsic activity and corrosion resistance of catalytic materials. Compared with bulk materials,

low-dimensional materials possess more exposed surfaces and a weaker thickness influence, making them excellent models for investigating surface local configurations.

In this report, taking the coordination environment of active sites as the entry point, we propose a universal multiscale "bulk–surface–interface" design strategy and methodology for engineering the coordination environment of active sites in low-dimensional non-precious-metal catalytic materials. We have constructed a library of pure-phase two-dimensional Fe-based non-precious-metal materials and revealed the key structure–property relationship and underlying mechanism by which bulk coordination symmetry governs HER catalytic performance. We further propose an inert-surface activation strategy induced by modulation of the d-band structure of active atoms within the surface, which breaks the intrinsically saturated coordination environment of inert surface sites and establishes a universal d-band width descriptor for transition-metal active sites, yielding an intrinsic activity 16 times that of commercial Pt/C. On this basis, we construct atomic-scale cross-dimensional interfaces by matching the metal electronegativity of materials of different dimensions to drive ordered self-assembly. The built-in electric field and electron transport channels generated at the interface optimize the charge distribution, enabling surface activation without structural collapse and achieving a 20-fold enhancement in stability, with stable operation for 3000 h under practical operating conditions.

**28** INVITED

## High-mass-loading Electrode Materials for Sodium-ion Batteries

**Junfei Liang 梁君飞**

*North University of China, China*

*Abstract not received at the time of printing.*

**29** INVITED

## Regulating Hydrogen-Bonding Chemistry for High-Performance Aqueous Ammonium-Ion Batteries

**Pu Hu 胡朴**

*Wuhan Institute of Technology, China*

Aqueous ammonium-ion batteries (AAIBs) have emerged as promising energy storage systems owing to their low cost, resource abundance, and environmental compatibility. The unique hydrogen-bonding chemistry of NH4+ offers opportunities for developing efficient and reversible charge-storage mechanisms. However, their performance remains limited by insufficient utilization of redox-active sites, structural degradation during cycling, and water-induced parasitic reactions. To address these challenges, we investigated crystal water regulation, defect engineering, and electrolyte design to improve ammonium-ion storage from the electrode framework to the electrolyte environment. Specifically, Crystal water was harnessed to regulate hydrogen-bond interactions within electrode frameworks, facilitating NH4+ migration and stabilizing the host structure. Defect engineering was employed to modify local coordination environments, improve reaction kinetics, and activate otherwise underutilized redox sites. Furthermore, electrolyte regulation enabled reconstruction of the hydrogen-bond network to suppress water activity, expand the electrochemical stability window, and improve temperature adaptability. These complementary strategies enhanced reversible capacity, rate capability, and cycling stability, while electrolyte optimization further enabled improved low-temperature performance and reduced self-discharge. These studies elucidate the roles of crystal water, local coordination environments, and electrolyte hydrogen-bond networks in ammonium-ion storage, providing insights into the design of high-performance aqueous ammonium-ion batteries.

30 INVITED

## Spin-Enhanced Electrocatalysis and Dynamic Electrochemical Interfaces

电子自旋增益电催化及电化学动态界面

**Jing Wang 王静**

*Yanshan University, China · 教授*

*Abstract not received at the time of printing.*

31 INVITED

## Local Coordination Engineering for Ultrahigh-Capacity Zinc Storage in Vanadium-Based Cathodes

调控局域配位环境——实现钒基正极材料超高容量储锌

**Yan Zhao 赵岩**

*Inner Mongolia University, China*

钒基正极具有多价态氧化还原中心是水系锌离子电池的理想电极材料。然而，由于 Zn2+传输缓慢、电子电导率有限和结构退化，传统的钒基正极往往无法完全发挥其固有的氧化还原化学性质，其实际容量有限，倍率性能较差。引入局域无序和氧空位有助于改善储锌动力学，而过度无序又可能削弱结构稳定性。如何兼顾活性位点可达性与骨架稳定性，是提升钒基正极性能的关键。

近日，我们研究团队将具有氧化还原活性的 Ag 引入短程有序钒酸盐，制备了低结晶 LC-Ag1.2V3O8 正极。并进一步将具有氧化还原活性的 Ag 引入短程有序的低结晶钒酸盐，通过重构 Ag-V-O 局域配位降低氧空位形成能，并提高 Ag/V 氧化还原位点的电化学可达性。低结晶骨架进一步稳定富缺陷配位环境、缓冲反复嵌锌引起的局部应变，使更多活性位点能够参与快速、可逆的储锌反应。两者协同促进赝电容储锌和 Zn2+迁移，使正极在 0.1 A g-1 下实现 525.51 mAh g-1 可逆容量，并在 8 A g-1 循环 5,000 圈后容量保持率 96.2%。

一种简便的水相组装方法可将多钒酸盐前驱体转化为低结晶度的银钒酸盐（LC-Ag1.2V3O8）。富含氧空位的银-钒-氧（Ag-V-O）配位结构激活了 Ag/V 耦合氧化还原反应，并加速了锌离子的传输，从而实现了 525 mAh g-1 的比容量。

32 INVITED

## Direct Synthesis of Hydrogen Peroxide

**Zengxi Wei 危增曦**

*Guangxi University, China · 副教授*

Hydrogen peroxide is an environmentally benign green oxidant with broad applications in chemical synthesis, environmental remediation, energy catalysis, healthcare and other fields. Although the conventional anthraquinone process enables large-scale industrial production of hydrogen peroxide, it suffers from high transportation and storage costs, compromised stability and insufficient operational flexibility for scenarios requiring trace supply, on-site utilization and high reactivity. Accordingly, shifting hydrogen peroxide production from centralized manufacturing to on-demand and on-site synthesis has emerged as a new research frontier. Centered on the developmental demands of on-site hydrogen peroxide generation technology, this review systematically summarizes the research progress in catalyst construction for direct $H_2$–$O_2$ synthesis of $H_2O_2$ and microreactor design. Particular emphasis is placed on analyzing the structure–activity relationship of catalysts and microreactor configurations, as well as discussing how synergistic optimization of catalysts and reactors affects $H_2O_2$ production efficiency and system stability. In view of the laboratory demand for continuous preparation of low-concentration hydrogen peroxide, the future prospects and potential applications of on-site $H_2O_2$ generation technology are outlined. This work offers new research insights for establishing a safe, efficient and green technical framework for on-demand hydrogen peroxide production.

33 KEYNOTE

## Towards Single Crystals of Covalent Organic Polymers/Frameworks

**Qichun Zhang 张其春**

*City University of Hong Kong, China · Professor*

Covalent organic polymers/frameworks (COPs/COFs) have caused many scientists' interest in both fundamental research (synthesis, properties, theoretical simulation, etc.) and possible applications (gas absorption/separation, catalysis, energy-related devices, sensing, imaging, and so on). In this talk, I will present our recent progress on the preparation of novel COPs/COFs single crystals as well as their diverse applications in optoelectrical devices.

34 KEYNOTE

## The Role of Interfaces in High-performance and Sustainable Organic Solar Cells and Photodetectors

**Nicola Gasparini**

*Imperial College London, UK · Associate Professor*

In recent years, lead-halide perovskites and organic semiconductors have been amongst the most exciting emerging technologies in optoelectronic applications, with record performances in photovoltaics and light-emitting diodes. For these record devices, the role of interfaces is fundamentals. In this talk, I will present novel electron transporting materials that are able to improve power conversion efficiency and fill factor (>80%) in organic photovoltaics. I will then show how to extend the detection of single junction perovskite by combining the advantages of perovskite and organic bulk-heterojunction materials to fabricate perovskite-organic heterojunction (POH) broadband photodetectors with ultra-low noise of 2 x 10-14 A Hz-1/2 and record high specific detectivity D* of 4.7 x 1012 Jones at 840 nm. We systematically studied the effect of the donor's highest occupied molecular orbital on the dark current (Jd) of the devices. We found that holes accumulate at the perovskite/BHJ interface under short circuit conditions, allowing a high rate of thermionic injection and leading to the enhanced photocurrent. Finally, we have demonstrated that our POH devices as NIR pulse oximeters with high-accuracy heartbeat monitoring at long distances (up to 2 meters).

35 KEYNOTE

## Light-Matter-Spin Interaction in Multiscale Chiral Nanostructures for Energy Conversion, Light Emission and Precision Nanomedicine

**Dong Ha Kim**

*Ewha Womans University, South Korea · Distinguished Professor*

The interplay between structural chirality and electronic spin, known as the Chirality-Induced Spin Selectivity (CISS) effect, has emerged as a transformative paradigm in materials science. This presentation highlights a series of pioneering studies that leverage chiral nanostructures to overcome fundamental limits in energy conversion, storage, and biomedical engineering. In the realm of energy, we demonstrate how chiral electrocatalysts can manipulate electron spin to suppress the formation of deleterious intermediates, thereby enhancing the efficiency of acidic water electrolysis and ammonia electrooxidation. By integrating antenna-reactor plasmonic systems with chiral interfaces, we achieved spin-polarized charge transfer that significantly boosts hydrogen evolution reactions in photocatalysis. Furthermore, the application of chirality extends to Li–O2 batteries, where it effectively suppresses singlet oxygen generation, leading to dramatically extended cycle lives. Beyond energy, the fundamental assembly of hierarchical chiral supramolecules is explored, revealing invertible chiroptical properties with record-breaking dissymmetry factors. Advancements in chiral architectures, detailing synthesis and applications of chiral macromolecules, and chiral perovskites for optoelectronic devices are also highlighted. These chiral platforms are further translated into the biomedical field. We introduce enzyme-like chiral plasmonic nanoparticles for optically tunable cancer therapy, enabling high-precision tumor targeting and minimized side effects. Collectively, these findings underscore the

"promise of CISS" and nanostructure design as a universal strategy. By controlling the spin and orbital degrees of freedom, we provide a roadmap for the next generation of sustainable energy systems and advanced therapeutic platforms.

37 INVITED

## Aerogel-Based Materials for Efficient Energy Conversion

基于气凝胶的高效能源转化材料

**Jing Yang 杨静**

*Hunan Normal University, China · 特聘教授*

面对实现“碳达峰、碳中和”目标的时代使命、保障国家能源安全的根本要求，开发兼顾低成本、高活性、长耐久性的电催化剂材料，构筑高效能源转换装置，已成为支撑国家重大战略需求的关键前沿领域。目前 Pt 基催化剂是一类十分优异的电催化剂材料，然而其本身的稀缺性和高成本严重阻碍了大规模商业化应用。一方面，通过构筑纳米化的 Pt 基电催化剂可以提升 Pt 利用率，暴露更多活性位点，可以有效减少 Pt 使用量，然而其往往面临着严重的电化学迁移熟化、团聚等问题，进而导致稳定性不足；另一方面，与非贵金属进行合金化，调控 Pt 电子状态，提升本征活性，也可以大幅降低 Pt 的用量，然而非贵金属组分的稳定性（尤其在强酸体系中）面临着严峻挑战。基于此，本报告将介绍如何从气凝胶的复合体系设计和结构控制出发，设计制备高效稳定的电催化剂材料[1-8]。通过三维多孔结构的构造、气凝胶骨架多位点协同和物理—化学双锁等手段，实现了气凝胶电催化剂高催化活性和长耐久性的兼顾。提出了一条从气凝胶复合体系设计与结构控制出发，制备高性能电催化剂体系的有效途径。

38 INVITED

## Current-Assisted Catalytic Removal of Air Pollutants and Its Enhancement Mechanisms

电流辅助大气污染物催化消除及其强化机制

**Yibo Zhang 张一波**

*Ganjiang Innovation Academy, Chinese Academy of Sciences, China · 研究员*

随着电能的逐渐绿色化及电力成本的降低，实现催化剂的实用型电气化将会促使催化甚至整个工业领域的巨大绿色化、经济化及智能化变革 [1]。相比传统热催化，电流辅助催化策略是一种采用更少能耗实现更高性能的新途径，颠覆了部分热催化领域的传统理念，其实用性强的特点有望开启催化剂新电气化时代。随着未来在技术、材料和机理多角度深入研究的推进，电流辅助催化在催化工业的使用占比将逐渐扩大，可在大气污染物治理（NOx 消除，VOCs 净化等），全球能源大规模绿色转型和碳中和的实现进程中起到重要的推动作用 [2,3,4]。

39 INVITED

## Where Biology Meets Materials: Artificial and Semi-Artificial Photosynthesis for Sustainable Fuels and Circular Chemistry

**Sai Kishore Ravi**

*City University of Hong Kong, China · Assistant Professor*

Where biology meets materials, new opportunities emerge for converting light and other ambient energy inputs into fuels and chemicals. I will begin with natural photosynthesis as a design blueprint, particularly its light-harvesting, energy-transfer and charge-separation functions, and use this to frame the continuum from natural to semi-artificial and fully artificial photosynthetic systems. I will first discuss semi-artificial platforms that integrate photosynthetic pigment-protein complexes with synthetic electrodes and functional materials, highlighting how interface engineering can preserve biological function while enabling charge extraction, storage and useful photochemical processes. I will then move to artificial semiconductor photocatalysts for solar-driven $H_2$ and $H_2O_2$ production, focusing on defect chemistry, heterointerfaces and redox-site engineering to control carrier transport and reaction selectivity. From this foundation, I will broaden the discussion from water splitting to Solar-to-X strategies in which waste-derived substrates participate in the redox chemistry. Particular emphasis will be placed on plastic circularity, including bio-photocatalytic plastic reforming that combines plastic-digesting enzymes with heterojunction photocatalysts, as well as

semi-artificial microbial-material hybrids for solar $H_2$ production. Finally, moving beyond photons, I will highlight our recent work in piezocatalysis and piezosynthesis, where mechanically induced polarization is used to drive $H_2$ and $H_2O_2$ formation. Together, these examples show how artificial and semi-artificial materials can integrate biological selectivity with engineered charge and polarization pathways to enable sustainable fuels and circular chemistry. I will conclude with perspectives on efficiency, stability, scalability and translation.

**40** INVITED

## Key Materials for High-Energy-Density and Fast-Charging Rechargeable Batteries

高能量密度/快充二次电池关键材料

**Guoxing Li 李国兴**

*Shandong University, China*

电动汽车的大规模普及需要大幅提升动力电池的能量密度和快充性能。锂硫电池被看做是下一代高能量密度电池的潜在储能设备，但锂负极侧枝晶的生长、低的库伦效率，以及硫正极侧穿梭效应、缓慢的硫转化动力学限制其实际应用。尤其是在快充条件下会引起巨大的电压极化和严重的析锂问题，进一步降低电池性能。鉴于此，本系列工作从电池的能量密度和快充性能入手，在锂硫电池和快充电池电极材料方面展开研究。在锂硫电池方面，通过稳定 SEI、人工保护膜的设计制备解决锂金属负极所面临的的问题，提升锂金属负极性能；同时设计高性能硫转化催化材料，大幅提升高负载、贫电解液情况下硫转化速率，从而实现高能量密度锂硫电池。在快充电池方面，从提升负极材料离子传输动力学的角度出发，通过官能团层间调制、自扩张离子传输通道构筑、电极材料空位工程以及建立离子抽运特性的异质结界面等策略调控离子在电极材料中的传输行为，加速离子的传输，从而在宽温域内让锂离子电池实现优异的快充性能。

**41** INVITED

## Catalyst Design and Mechanistic Regulation for Waste Carbon Valorization

**Shuai Yue 岳帅**

*Taiyuan University of Technology, China · 副教授*

*Abstract not received at the time of printing.*

**42** INVITED

## Two-Dimensional Nanofluidic Membranes for Osmotic Energy Harvesting

**Qianqian Zhang 张倩倩**

*Beijing University of Technology, China*

Osmotic energy from water bodies with different salinity-gradients represents an abundant, green and zero-carbon energy source. Efficient harvesting and utilization of such energy remains a challenging research topic. Reverse electrodialysis (RED), with ion-selective membranes as core components, is regarded as one of the most industrially promising technologies for osmotic power generation. It converts transmembrane salinity-gradient energy directly into electricity by enabling the transport of monovalent charged ions across ion-selective membranes. Therefore, developing ion-selective membranes with high ion selectivity and ionic conductivity lays the foundation for high-efficiency salinity-gradient power generation. In recent years, our group has adopted natural layered clay as raw material to design two-dimensional nanofluidic membranes with combined ion selectivity and permeability. By optimizing mass transport and structural stability via membrane architecture engineering, an osmotic power density exceeding 20 W $m^{-2}$ is achieved, which greatly outperforms the industrial benchmark (5 W $m^{-2}$) for practical applications. The membrane system can deliver stable power output over 30 days and directly drive continuous operation of small electronic devices. Moreover, the clay-based membranes developed by our team feature facile scalable fabrication and low cost. On this basis, we assembled a small-scale RED stack using as-prepared clay-based cation and anion membranes for the first time, and carried out pilot-scale validation in the salinity-gradient system of a seawater desalination plant. The pilot results demonstrate that at a medium-scale seawater desalination site with a

ten-thousand-ton freshwater production capacity, 100 membrane stacks can realize megawatt-level electricity recovery annually. This series of studies offers new insights into the development of scalable high-performance ion-selective membrane materials and is expected to promote the advancement and practical deployment of membrane-based new energy technologies.

**43** INVITED

## In Situ Interfacial Studies of Spectrum-Electro-Chemo-Mechanical Coupled Systems for Rechargeable Batteries

**Weifeng Huang 黄伟峰**

*Inner Mongolia University, China*

To address the complex interfacial evolution during battery reactions and the difficulty of conventional ex situ characterization in capturing dynamic information, we designed and constructed an in situ characterization platform coupling with "spectrum-electrochemistry-physical field" multi-field, enabling in situ tracking and resolution of the interface during battery reactions and providing reliable methodological support for revealing battery failure mechanisms. Focusing on in situ interfacial studies in aqueous zinc-ion batteries, this report systematically tracks and resolves the zinc deposition/stripping process by combining high-resolution nanoscale CT imaging with other in situ methods such as XRD and optical flow analysis. The dynamic evolution of interfacial morphology, phase composition, and physical fields is clearly revealed, ultimately yielding a complete picture of the zinc deposition–stripping process. This platform and its multi-method coupling strategy provide a powerful tool for understanding interfacial behavior and failure mechanisms in aqueous zinc batteries, and offer a transferable technical pathway for in situ interfacial studies of other battery systems.

**44** INVITED

## Electrode-Electrolyte Interface Engineering towards Efficient Energy Storage

**Wenjun Zhang 张文军**

*City University of Hong Kong, China*

Wenjun Zhang Center of Super-Diamond and Advanced Films (COSDAF) & Department of Materials Science and Engineering, City University of Hong Kong, China Aqueous zinc-ion batteries have gained significant attention as promising candidates for next-generation large-scale energy storage due to their high safety, environmental friendliness, and cost-effectiveness. However, the performance of Zn anodes is hindered by several challenges, including uncontrolled dendrite growth, slow deposition kinetics, and chemical corrosion associated with hydrogen evolution reactions, which severely limit their cycling stability. This presentation will highlight our recent efforts to enhance the efficiency and stability of energy storage and conversion through electrode-electrolyte interface engineering. Key strategies include the fabrication of cetyltrimethylammonium functionalized carbon nanotube hosts, electrolyte engineering via anion regulation, the introduction of aprotic solvents, and the development of artificial solid electrode interphases using materials such as nano-diamond, amorphous zinc pyrophosphate, natural cellulose, and boehmite.

# 分论坛六

SYMPOSIUM 06 · AI EMPOWERING SCIENCE COMMUNICATION AND PUBLISHING

AI 赋能科学传播与学术出版

06

AI EMPOWERMENT · MATERIALS INNOVATION · INTELLIGENT MANUFACTURING

01 INVITED

## An Attempt and Exploration on the Integration and Transformation of Funded Research Achievements from the National Natural Science Foundation

国家自然科学基金资助成果贯通与转化的尝试与探索

**Dong Li 李东**

*National Natural Science Foundation of China*

基础研究是整个科学体系的源头，是所有技术问题的总机关。当前，国家对加强基础研究、发展新质生产力、深化科技评价体系改革作出系统部署，要求打通基础研究、应用开发、成果转化的创新链条，以原始创新支撑高水平科技自立自强。国家自然科学基金委员会科学传播与成果转化中心以服务科学基金事业为根本宗旨，承担科学基金发展战略、资助政策与资助绩效传播，以及资助成果宣传、推广与转化。

近年来，中心立足科学基金资助成果，着力打通成果管理、转化与传播全链条。通过建设开放共享平台、多源汇聚资助成果、推行科研人员标识，逐步筑牢可信成果数据底座；联合地方政府、企业，搭建需求与成果双向对接的协同机制，开展资助成果遴选推介与供需对接，积极探索成果转化路径；同时，打造融合传播矩阵，持续提升科学基金成果的传播力与影响力，为激发原始创新活力营造良好氛围。

02 INVITED

## Challenges and Governance of AI's Deep Involvement in Academic Publishing

AI 深度介入学术出版的挑战与治理

**Hong Xiao 肖宏**

*Tongfang Knowledge Network Digital Technology Co., Ltd.*

生成式 AI 已覆盖选题、写作、审稿、传播全链路，成为科研人员的 "研究助手" 与 "写作助手"，但也催生论文工厂工业化造假、AI 审稿滥用、真伪难辨等问题，冲击学术诚信。对此，报告提出规范、技术、主体三位一体治理路径：坚持 AI 不得署名、使用须透明披露、人类作者负全责；以 AIGC 检测等技术构筑防线（检测准确率 95%，实测 35% 投稿含 AI 写稿）；强化编辑的 "价值锚点" 作用与行业标准建设。核心主张为 "以透明构建信任，以规范促进创新"，构建人机协同、可信可控的学术出版新生态。

03 INVITED

## The Application and Usage Boundaries of AI in the Management of Research Integrity

AI 在科研诚信管理中的应用与使用边界

**Silvia Luo 罗丹**

*Wiley*

《自然》2025 年的统计显示，2014—2024 年全球撤稿率最高的十家机构中有七家来自中国，中国科研论文平均撤稿率为 0.3%，是全球平均水平的三倍——论文工厂、图像篡改、虚假引用与机器代写，正在重塑出版方对"诚信"的判断方式。我的分享将从出版社一侧讲起：国际出版社如何借助 AI 识别机器生成内容、异常出版行为、图片造假、作者身份与参考文献质量等七类风险。随后落到作者一侧，逐一厘清资料收集、数据统计、图表制作、论文写作与审稿各环节里 AI 的可为与不可为，说明写作、研究方法、文献综述、代码、数据分析与图表六类使用中哪些必须披露、如何撰写声明，以及照片编辑与证据性图像这类不可触碰的红线。AI 改变的是效率，改变不了作者对内容的最终责任。

04 INVITED

## From Content to Capabilities: Unlocking the Value of Scholarly Knowledge in the AI Era

从内容到能力：AI 时代学术知识的新价值

**Jing Li 李晶**

*Wiley*

本报告探讨人工智能时代学术知识价值的演进。随着 AI 技术的发展，学术知识的使用方式和应用场景正在不断拓展，不仅继续服务于人类的阅读、研究与知识创造，也日益成为 AI 理解、推理和专业应用的重要基础。随着 AI 深入科研、医疗及产业研发等专业领域，高质量、可信且持续更新的知识体系正发挥越来越重要的作用。通过介绍 Wiley 在科研发现、医药研发和临床决策等领域的探索，报告展示了学术出版机构如何发挥自身在专业知识与学术生态方面的优势，拓展知识的应用场景与服务模式，推动学术知识从内容资源向专业能力延伸，释放其在 AI 时代的新价值。

Artificial intelligence is reshaping how scholarly knowledge is accessed, used, and applied. While scholarly knowledge continues to support human learning, research, and knowledge creation, it is also becoming an increasingly important foundation for AI-powered reasoning and professional applications.

As AI advances across scientific research, healthcare, and industrial R&D, the demand for high-quality, trusted, and continuously updated scholarly knowledge is growing. Drawing on Wiley's initiatives in scientific discovery, drug development, and clinical decision-making, this presentation explores how scholarly publishers can leverage their expertise in scholarly content and research ecosystems to enable new applications and develop innovative service models.

It highlights the evolving role of scholarly publishers in extending the value of knowledge beyond content delivery to enabling professional capabilities, unlocking new opportunities for scholarly knowledge in the AI era.

05 INVITED

## Digital publishing and AI application at Youke Publishing

**Hailiang Li 李海亮**

*Youke Publishing*

Youke Publishing is a professional publisher of scientific and technological journals, and has established a collection of nearly 200 journals in the field of engineering and technology. Youke Publishing has built its own comprehensive knowledge base, covering journals, books, and patents. On this foundation, we have developed two platforms: the Engineering Innovation Knowledge Service Platform, which primarily serves users in China, and the Web of Tech Platform, which is designed for global audiences. The Web of Tech (WOT) platform has basically established a complete publishing workflow covering DOI registration, automated import of structured typesetting files, multi-format full-text online reading, PDF-based ChatPaper, AI full-text translation, and Chinese-English bilingual interfaces. Besides. Among the two new journals of Youke Publishing, Chain has migrated from the IEEE publishing platform to WOT, and Hyper made its debut on the WOT platform. The WOT has basically realized the full-process publishing of in-house journals.

06 INVITED

## AI Assisted Submission Screening in Wiley Physical Sciences Journals

Wiley 旗下物质科学期刊的 AI 辅助审稿策略与审稿机制

**Alick Zu 祖萌**

*Advanced Science (Deputy Editor), Wiley*

Wiley 作为一家有 200 多年发展历史的公司，始终致力于帮助机构与个人拓展通向成功所需的知识与技能。我们提供科学、技术、医学和人文社科期刊与在线学习、评估与认证相结合的解决方案，帮助高校、研究机构、学术团体、企业、政府以及个人提高学术和专业影响力。作为研究人员，将科研成果整理成文并发表在合适的期刊上是科研工作中非常重要的一个环节。本次报告将着重介绍 Wiley 旗下的材料科学领域期刊，并从编辑的角度介绍 AI 辅助审稿的流程，并给出一些在投稿过程中需要注意的事项和技巧，希望对大家有所启发和帮助。

07 INVITED

## Exploring Aggregate Science: An Introduction to Aggregate

**Qiyao Li 李琦瑶**

*Aggregate*

Collective science focuses on the aggregation behavior, structural evolution and collaborative functions of multi-component systems, explores the emergence of performance in complex aggregates, and provides new ideas for cross-disciplinary innovation in fields such as materials, energy and life sciences. This report will introduce the publishing positioning, disciplinary layout and development progress of the Aggregate journal, share its practices in column construction, high-quality result publication and international academic exchanges, and discuss the paths for deepening communication and mutual growth between the journal and authors.

08 INVITED

## Wiley 助力高质量期刊发展

**Thomas Wang 王赫**

*Wiley*

本报告围绕 Wiley 助力高质量期刊发展展开，重点包括：精准定位作者活动，聚焦高质量期刊增长，拓展读者群体与影响。

09 INVITED

## New Cornerstone Science Foundation: Stable Support for Discovery Research in China

**Yong Wang 王永**

*New Cornerstone Science Foundation, Beijing, China*

The New Cornerstone Science Foundation is China's largest non-governmental, non-profit funding organization dedicated to scientific research. Guided by the scientific community, it supports exceptional scientists with stable, long-term resources for curiosity-driven discovery research, while building platforms for international academic exchange, science education and public engagement. This report outlines the Foundation's two core funding programs and its scientific community initiatives. The New Cornerstone Investigator Program, established in 2022, supports well-established scientists under 55 years of age in the basic sciences. Over ten years it plans to select 200-300 investigators with a total commitment of 10 billion RMB (1.4 billion USD), providing each with 15 or 25 million RMB over five years, renewable for a second five-year term. The Xplorer Prize, established in 2018, honours up to 50 early- and mid-career scientists, engineers and physician scientists each year (men under 45, women under 48) in basic sciences and frontier technologies, awarding 3 million RMB over five years. Both programs follow a "people, not projects" philosophy: funding is fully flexible, with no KPIs, no timeline for deliverables and no strings attached, and selection is merit-based through vigorous international peer review. To date, 139 investigators and 397 Xplorer Prize awardees have been selected, all working at the frontiers of basic science and frontier technology. Beyond funding, the Foundation fosters interdisciplinary collaboration through New Cornerstone Symposia, Investigator Meetings, public Forums and online Webinars, encouraging dialogue and the sharing of unpublished work.

# 专题论坛一

SPECIAL TOPIC FORUM S01 · SUPERCONDUCTING MATERIALS

超导材料

S01

AI EMPOWERMENT · MATERIALS INNOVATION · INTELLIGENT MANUFACTURING

01 KEYNOTE

## Inspiration and Perspective from the Commonality of Three Type Unconventional High Temperature Superconductors

**Haihu Wen 闻海虎**

*Nanjing University, China*

*Abstract not received at the time of printing.*

02 INVITED

## Quantum Griffiths Singularity in Superconductors: A 10-Year Overview

**Jian Wang 王健**

*Peking University, China*

For the first time, we experimentally discovered a new quantum phase transition, i.e. quantum Griffiths singularity, in two-dimensional superconducting thin films, which reveals the prominent influence of disorder and dissipation on quantum phase transitions and expands the universality class of quantum phase transitions.

03 INVITED

## Advances in High-Field HTS Magnet Technology for Next-Generation Particle Accelerators

**Qingjin Xu 徐庆金**

*Institute of High Energy Physics, CAS, China*

The Institute of High Energy Physics (IHEP) of the Chinese Academy of Sciences is pursuing the advanced high field HTS superconducting magnet technology for the next-generation particle accelerators. Significant progresses have been achieved in the past years: world's first achievement of over 14 T dipole field in the aperture with ReBCO insert coils at 4.2 K. The engineering current density of the Iron Based Superconductor (IBS) has been continuously increased significantly in collaboration with the Institute of Electrical Engineering (IEE) of the Chinese Academy of Sciences; the IBS model solenoids reached 49 A stable operating current at 35 T background field; the transposed IBS cable reached a quench current of 7100 A, and the quench propagation speed of the IBS conductor has also been experimentally measured, showing its superiority over traditional HTS conductors: easy to protect during quench, better mechanical properties and much lower cost.

04 INVITED

## Key Technologies and Challenges of Superconducting Magnets for Magnetic Confinement Fusion

**Jinxing Zheng 郑金星**

*Hefei Institutes of Physical Science, CAS, China*

*Abstract not received at the time of printing.*

05 INVITED

## Applications and Challenges of Superconductors in Fusion Magnets

**Fang Liu**

*Institute of Plasma Physics, CAS, China*

*Abstract not received at the time of printing.*

06 INVITED

## A Surrogate Model for High-Temperature Superconducting Magnets to Predict Current Distribution with Neural Networks

**Timing Qu**
*Fudan University, China*
*Abstract not received at the time of printing.*

06 INVITED

## Study on Loss and Temperature Characteristics of 10 kV Three-Phase Coaxial High-Temperature Superconducting Cables

**Jin Fang**
*Beijing Jiaotong University, China*
*Abstract not received at the time of printing.*

07 INVITED

## 高温超导钉扎磁浮关键技术研究进展

**Zigang Deng 邓自刚**
*Southwest Jiaotong University, China*

高温超导钉扎磁浮技术利用超导体与永磁轨道之间的磁通钉扎效应，实现无源自稳定悬浮，具有结构简单、运行能耗低等特点，是未来超高速磁浮交通的重要发展方向。面向高温超导钉扎磁浮系统高速化与工程化应用需求，本报告系统介绍近年来在超导材料性能优化、永磁轨道结构设计、磁通调控及振动控制等方面的研究进展。重点介绍块材表面人工孔槽磁通调控技术、V 型空间永磁轨道构型及离散化磁化角优化方法，并总结预载调控和磁流变阻尼器半主动控制在提升悬浮性能、降低振动响应方面的研究成果。相关研究为低真空管道超高速高温超导钉扎磁浮系统的结构设计、性能优化及工程化应用提供了技术支撑。

08 ORAL

## Low-Temperature Processing and Doping Optimization of MgB2 Superconductors

**Jinghan Gao 高婧涵**
*Institute of Electrical Engineering, CAS, China*

Magnesium diboride (MgB2) has attracted considerable interest for superconducting applications owing to its relatively high critical temperature, low anisotropy, weak grain-boundary weak-link behavior, and low material cost. However, the conventional synthesis of MgB2 generally requires relatively high reaction temperatures, while its weak intrinsic flux pinning leads to a rapid degradation of critical current density((Jc) under applied magnetic fields. In this work, low-temperature processing and chemical doping strategies are investigated to regulate the phase formation, microstructure, flux pinning, and high-field superconducting performance of MgB2. Mg(BH4)2 was first explored as an alternative precursor for the low-temperature fabrication of MgB2. By clarifying its thermal decomposition pathway, nanoscale Mg, B, and MgB2 intermediates were obtained after heat treatment at 520 °C. Subsequent hot pressing enabled the formation of dense nanostructured MgB2 at substantially reduced temperatures compared with conventional solid-state synthesis. The MgB2 bulk prepared at 650 °C for 3 h exhibited a superconducting transition temperature of 37.4 K and a Jc of 4.21×105 A/cm2 at 10 K in self-field. The refined grain structure provides abundant grain-boundary pinning centers, resulting in a Jc of 5.07×104 A/cm2 at 10 K and 3 T. To further improve the density and provide a suitable platform for doping studies, a pressure-assisted Mg infiltration process was subsequently developed. By applying a moderate mechanical driving force during liquid Mg infiltration, residual Mg was effectively suppressed while high density and good grain connectivity were maintained. The optimized undoped MgB2 bulk reached a relative density above 85% and a Jc of 1.35×105 A/cm2 at 4.2 K and 3 T, demonstrating the suitability of this route for constructing high-performance doped MgB2 bulks. Based on this processing platform, carbon-containing

dopants were further introduced to enhance high-field superconducting performance. For polycarbosilane (PCS) doping, the in-situ formation of highly reactive SiC promotes C substitution at B sites, while Mg2Si secondary phases contribute additional flux pinning. The results reveal that the morphology and distribution of secondary phases critically determine the balance between flux pinning and grain connectivity. Ball milling produces discrete nanoscale Mg2Si particles and achieves an optimal combination of C substitution, grain refinement, and effective current transport, yielding a Jc of 2.29×104 A/cm2 at 5 K and 7 T and increasing Hc2 at 20 K from 8.73 to 10.8 T. PVP was further employed as an organic carbon precursor. PVP-derived carbon induces partial C substitution, grain refinement, carbon-rich pinning regions, and reduced MgO formation. The optimized 10 wt% PVP-doped sample achieved a Jc of 1.46×103 A/cm2 at 20 K and 5 T, approximately 8.5 times that of the undoped sample, together with Hirr and Hc2 values of 9.58 and 12.05 T at 20 K, respectively. These results demonstrate that the superconducting performance of MgB2 can be effectively optimized through coordinated control of precursor reactivity, processing temperature, dopant chemistry, secondary-phase morphology, flux pinning, and grain connectivity.

**09** ORAL

## Physical Properties of Rare-Earth-Tuned Kagome Materials

**Xiaofan Yang 杨小帆**

*Northwest Institute for Non-ferrous Metal Research, China*

Kagome metals provide an intriguing platform for exploring the interplay among geometrical frustration, electronic correlations, magnetism, and nontrivial band topology. Here, we systematically investigate the magnetic and electronic transport properties of two families of mixed-rare-earth kagome materials, REMn6Sn6 and REV6Sn6 (RE = rare-earth elements). By introducing a medium-entropy Ho-Tb-Gd rare-earth composition, we investigate its effects on magnetic interactions and electronic states in the magnetic Mn-based and comparatively nonmagnetic V-based kagome lattices. By introducing different rare-earth constituents, we explore how rare-earth substitution affects magnetic interactions and electronic states in the magnetic Mn-based and comparatively nonmagnetic V-based kagome lattices. Temperature-dependent Hall measurements reveal distinctly different transport behaviors in the two systems. In the V-based compounds, the dominant carrier type changes with temperature, indicating a pronounced evolution of the electronic transport properties. In contrast, the Mn-based compounds exhibit multiple magnetic phase transitions, accompanied by characteristic changes in the Hall response and anomalous Hall effect. Furthermore, pressure is employed as an additional tuning parameter to investigate the evolution of the magnetic and transport properties in both systems.

**10** INVITED

## 上海 110 kV/8 km 超导电缆输电工程研究进展

**Xihua Zong 宗曦华**

*Shanghai Electric Cable Research Institute Co., Ltd., China*

结合上海 110 kV/2 kA、8 km 超导输电工程需求，在 1.2 km 示范工程成功运行 5 年的基础上，面向算力中心进站供电等应用场景，围绕超导电缆本体与绝缘、低温系统、终端附件与接头、电力系统适配与控制系统等模块开展研究。目前项目已进入性能试验验证阶段，并针对电流引线失效、电气缺陷等问题完成优化迭代。通过本研究，将为后续更高电压等级、更长距离超导输电工程提供重要的研究基础。

**11** INVITED

## Research on High-Temperature Magnet Cooled by Dielectric at 50 K

**Qingquan Qiu 邱清泉**

*Institute of Electrical Engineering, CAS, China*

*Abstract not received at the time of printing.*

12 INVITED

## High-Field and Reentrant Superconductivity in UTe2

**Toni Helm**

*High Magnetic Field Laboratory (HLD-EMFL), Helmholtz-Zentrum Dresden-Rossendorf, Germany*

Understanding mechanisms that can strengthen and enhance the robustness of superconductivity against external perturbations, such as high temperatures, strong magnetic fields, or electrical currents is key to improved superconducting applications. This motivates investigations of the fundamental properties of unconventional superconductors under challenging conditions. The heavy-fermion superconductor UTe2 exhibits signatures of multiple distinct superconducting phases with upper critical fields reaching beyond 70 T. A spin-triplet ground state has been proposed. In this presentation, I will present our recent work on UTe2. We conduct electrical magnetotransport measurements on single-crystalline structures, produced by focused-ion-beam assisted microfabrication, in steady and pulsed magnetic field up to 36 and 70 T. In particular, we look at Hall effect [1], magnetic torque [2], magnetic quantum oscillations [3] and angle-dependent magnetoresistance oscillations [4].

13 INVITED

## Epitaxy of FeAs-based Heterostructures and Interface Superconductivity

**Canli Song 宋灿立**

*Tsinghua University, China*

*Abstract not received at the time of printing.*

14 INVITED

## 高温超导带材产业化发展现状

**Chuanbing Cai 蔡传兵**

*Shanghai Creative Superconductor Technologies Co., Ltd. & Shanghai University, China*

REBCO 二代高温超导带材是高场超导磁体、超导电力装备的核心基础材料，也是当前超导产业化的研究热点。国内经过多年攻关，在金属基带、缓冲层、REBCO 超导层沉积等核心环节实现自主可控，带材超导性能达到国际先进水平，千米级长带制备能力稳步提升，已形成国产化产业链。随着聚变磁体等应用需求的增长，高温超导带材产业正加快向高性能、低成本和规模化方向发展，但仍面临长带性能均匀性与批次稳定性不足、低温强场载流能力、临界电流的各向异性调控、高强度金属基带和带材制造成本较高等挑战。本报告梳理国内外 REBCO 带材产业化现状，剖析现阶段关键技术瓶颈与产业痛点，为国内 REBCO 带材技术升级和工程化应用提供参考。

15 INVITED

## Progress in Research of Practical Superconducting Materials

**Qiang Guo 郭强**

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*Abstract not received at the time of printing.*

16 INVITED

## Scaling-up and R&D of 2G-HTS Tapes at Shanghai Superconductor Technology

**Jiamin Zhu 朱佳敏**

*Shanghai Superconductor Technology Co., Ltd., China*

*Abstract not received at the time of printing.*

17 INVITED

## The Research and Industrialization Progress of 2G-HTS Tapes Based on MOCVD Technology in China

**Yulei Chen 陈玉雷**

*East Superconducting Technology, China*

Introducing the progress of EastSuper in the industrialization of second-generation high-temperature superconducting tapes, elaborating on the performance of its products, and presenting the latest advanced processing technologies in the tape industry to provide references for the optimization of relevant industrial processes and technical research.

18 INVITED

## Scalable Production of PLD-Grade REBCO Superconducting Targets: Phase Purity, Carbon Control and Coated-Conductor Performance

**Lei Shi 石磊**

*Western Superconducting Technologies Co., Ltd., China*

REBCO coated conductors for high-field magnets, superconducting power devices and advanced medical systems are produced mainly by pulsed laser deposition (PLD), which today dominates global tape manufacturing. As an indispensable core consumable in the PLD process, the superconducting target governs film composition and, ultimately, the current-carrying capability of the tape. Its fabrication is therefore subject to exceptionally stringent requirements on powder purity, phase purity and the forming quality of large-size targets We designed and built a complete manufacturing chain for REBCO targets — powder mixing, phase-forming sintering, cold pressing and target densification — and defined the key control parameters and performance indicators of each step. This resolved three bottlenecks: low phase purity of the superconducting powder, difficult forming of large-area targets, and low production efficiency, improving both the quality and the batch-to-batch consistency of powder and targets. Unlike conventional hot-press routes, an integrated cold-pressing and high-temperature-sintering route was established, enabling stable fabrication of targets 8–12 in. in diameter (Ø200–300 mm) and 10 mm in thickness. Targets were evaluated by XRD for phase composition, SEM for microstructure, and benchmark PLD coating runs on tape production lines. The precursor powder is chemically pure to above 99.9%, and the sintered targets retain a REBCO phase purity (XRD) above 99% with residual carbon controlled below 500 ppm. Production-level validation was carried out on two independent tape manufacturing lines. Tapes 12 mm wide fabricated from pure EuBa1.9Cu3O7 targets reached a critical current of 752 A at 77 K in self-field, and 704 A was obtained under the same measurement conditions from EuBa1.9Cu3O7 + 3.5 mol% $BaHfO_3$ targets. Both results confirm that the targets support stable deposition in routine PLD production.

19 INVITED

## 不同能量 Xe 离子辐照对 Y(Gd)BCO 超导性能的影响

**Hao Yu 于昊**

*Institute of Electrical Engineering, CAS, China*

Y(Gd)BCO 因其较高的临界电流密度、临界温度和临界磁场而在多个领域发挥着重要作用。然而，其临界电流密度在强磁场下会发生显著下降。在本文中，通过能量为 45MeV 和 65MeV 的 Xe 离子辐照可提高 Y(Gd)BCO 带材在磁场下的的临界电流密度，尤其是在低温和高磁场条件下。与能量为 45MeV 的 Xe 离子辐照相比，用能量为 65 MeV 的 Xe 离子进行辐照所需较低辐射剂量就能显著提高其临界电流密度。能量为 65MeV 的 Xe 离子辐照会在 Y(Gd)BCO 中产生直径为 10-20nm 的球形缺陷。这使得 Y(Gd)BCO 的 c 轴织构变差。相关内容可为针对不同应用场景下通过 Xe 离子辐照提升 Y(Gd)BCO 带材性能提供参考。

20 INVITED

## Supersaturation-Driven Defect Engineering for Enhanced Flux Pinning in FF-MOD YBCO Films via Yttrium Stoichiometry Control

**Jiangtao Shi 史江涛**

*Xi'an Technological University, China; Karlsruhe Institute of Technology, Germany*

Supersaturation serves as the primary thermodynamic driving force for nucleation, governing the crystallographic orientation and microstructural evolution of superconducting films. In this study, we investigated the impact of the yttrium stoichiometry (x = 0.8, 1.0, 1.2) of $Y_xBa2Cu3O7-\delta$ films grown via fluorine-free metal-organic deposition (FF-MOD). By tuning the yttrium content, we effectively modulated the transient liquid-phase supersaturation, driving a fundamental transition in the defect architecture and vortex pinning dynamics. The Y-deficient film (Y0.8BCO), grown under lower supersaturation, lacks a competing dense 3D defect network. Consequently, its microstructural landscape is dominated by localized planar stacking faults, which provide robust 2D correlated pinning and sustain a broader vortex trapping angle (θT). Conversely, high supersaturation in the Y-rich film (Y1.2BCO) generates a dense 3D network of isotropic defects. These fine-scale disorders dimensionally match a reduced in-plane coherence length (ξab), acting as efficient core pinning centers that enhance the self-field critical current density (Jc) to 2.0 MA $cm^{-2}$ at 77 K.

# 专题论坛二

SPECIAL TOPIC FORUM S02 · 2D MATERIALS

二维材料

S02

AI EMPOWERMENT · MATERIALS INNOVATION · INTELLIGENT MANUFACTURING

01 KEYNOTE

## Phase Engineering of Nanomaterials (PEN): 2D Materials

**Hua Zhang 张华**

*City University of Hong Kong, Hong Kong, China*

I will summarize the recent research on phase engineering of nanomaterials (PEN) in my group, particularly focusing on the rational design and synthesis of novel two-dimensional (2D) materials with unconventional phases for various promising applications. For example, for the first time, we have successfully prepared novel hexagonal-close packed (hcp) 2H-Au nanosheets by using wet-chemical method. Besides, metastable 1T'-phase group VI transition metal dichalcogenides (TMDs), e.g., WS2, WSe2, MoS2, MoSe2, WS2xSe2(1-x) and MoS2xSe2(1-x), have been prepared using gas-solid reactions. Impressively, the 1T'-MoS2-supported single-atomically dispersed Pt (s-Pt) atoms with Pt loading up to 10 wt% exhibit superior performance in hydrogen evolution reaction. Importantly, 1T'-TMD monolayers can be stabilized on 4H-Au nanowires, which have been used for ultrasensitive SERS detection. Moreover, the salt-assisted 2H-to-1T' phase transformation of TMDs have been achieved, and the phase transformation of TMDs during our developed electrochemical Li-intercalation process has been observed. Impressively, the lithiation-induced amorphization of Pd3P2S8 has been achieved. Currently, my group focuses on the investigation of (crystal) phase-dependent physicochemical properties, functions and applications in catalysis, (opto-)electronic devices, clean energy, chemical and biosensors, surface enhanced Raman scattering, water remediation, photothermal therapy, etc., which are quite unique and very important not only in fundamental studies, but also in future practical applications.

02 KEYNOTE

## Van der Waals Material Devices for Logic, Memory and Computing

**Han Wang 王晗**

*The University of Hong Kong, Hong Kong, China*

In this talk, the recent academic and industrial development of van der Waals material based devices for advanced memory and computing technologies will be discussed. Two-dimensional (2D) transition metal dichalcogenides materials are promising candidates for advanced logic transistor applications. It however still faces difficulties towards practical commercialization due to challenges in device contact resistance, gate dielectric technology, integration process development, as well as its reliability and yield. In the first part of the talk, I will discuss our recent work in addressing some of these issues. Moreover, the unique physical properties of 2D materials also offer opportunities for developing novel memory and computing device technologies that can result in substantial performance improvement over traditional semiconductor devices as well as enabling new device and circuit functionalities difficult to achieve using conventional technologies. In the second part of the talk, I will discuss our work in developing such new semiconductor devices including 2D material based ferroelectric tunneling junction memory, kernel function computing device for support vector machine, and stochastic neuromorphic devices for efficiently solving combinatorial optimization problems.

03 KEYNOTE

## High-Pressure Modulation of Optoelectronic Properties in Layered Van der Waals Materials

**Bingbing Liu 刘冰冰**

*State Key Laboratory of High Pressure and Superhard Materials, Jilin University, China*

Optoelectronic functional materials with tunable spectral response are central to high-performance photoelectric energy conversion, yet effective strategies for continuously engineering their band structure remain limited. Pressure offers a potent and direct external stimulus for this purpose, as it modifies crystal structure and electronic structure without changing chemical composition. Here we show that high-pressure techniques provide a general route to

broaden the spectral response range and enhance the optoelectronic performance of functional materials [1–4]. Unlike conventional methods, pressure engineering effectively overcomes the intrinsic bandgap limitation of photosensitive materials. Continuous pressure tuning of the bandgap and optical absorption extended the spectral response of these materials into the near-infrared region, including the optical communication band, and improved their photocurrent and responsivity by several orders of magnitude. We further realized a giant in-plane bulk photovoltaic response in the in-plane nonpolar layered bulk crystal γ-InSe through pressure-induced symmetry breaking. The accompanying lattice distortion yields an in-plane photocurrent anisotropy ratio as high as 280, notably larger than those of other layered systems, while the bulk photovoltaic coefficient of 0.015 V-1 under 635 nm excitation exceeds the values reported for state-of-the-art bulk materials and thin films. These results demonstrate that pressure can lift the symmetry-imposed cancellation of shift-current contributions, providing a general pathway to engineer large in-plane bulk photovoltaic responses in layered materials.

**04** KEYNOTE

## Discovering Novel Magnetic Phases via Magnetic Force Theory and AI-Driven Materials Design

**Myung-Joon Han**

*Korea Advanced Institute of Science and Technology, South Korea*

In this talk, I present a unified framework for discovering novel magnetic materials by integrating magnetic force response theory (MFT), high-throughput first-principles calculations, and emerging AI-driven materials design strategies. We first develop an ab-initio high-throughput approach to identify frustrated magnetic systems on Kagome and triangular lattices. By combining density functional theory with MFT-based exchange interaction analysis and effective spin Hamiltonians, we systematically screen insulating 3d transition-metal compounds. This approach not only reproduces known frustrated magnets but also predicts previously unexplored candidates, revealing magnetic ground states governed by competing exchange interactions and lattice geometry. Building on the noncollinear extension of MFT, we further establish a multi-scale workflow to explore emergent topological spin textures. By integrating first-principles-derived magnetic interactions with atomistic spin simulations, we perform a comprehensive search across monolayer transition-metal dichalcogenides with diverse crystal structures and compositions. This approach uncovers a wide range of noncollinear and topologically protected spin configurations, including skyrmions and bimerons, and elucidates their microscopic stabilization mechanisms. Finally, we extend our discovery paradigm beyond existing materials databases by incorporating generative AI techniques. Using a diffusion-based crystal generation model combined with targeted screening and first-principles validation, we identify new candidate altermagnets—an emerging class of magnetic materials characterized by zero net magnetization and momentum-dependent spin splitting. Starting from tens of thousands of generated structures, we apply symmetry compatibility tests, AI classification, and DFT+U validation to isolate robust candidates. This workflow yields several previously unknown altermagnets, including systems exhibiting sizable spin splitting, demonstrating the effectiveness of integrating generative models with physics-based screening.

**05** INVITED

## Reliability of 2D Materials: Linking Device Instabilities to Microscopic Defects

**Dominic Waldhör**

*Institute for Microelectronics, TU Wien, Austria*

Two-dimensional (2D) semiconductors offer promising routes to continued transistor scaling. However, charge trapping at defects in the gate stacks can severely compromise the stability of 2D devices, leading to bias temperature instability (BTI) and hysteresis. While these mechanisms are generally undesirable, they also reveal the electrical response of the responsible microscopic traps. Here, we present a multi-scale modeling approach that connects electrical characterization with atomistic calculations and device simulations, which allows us to identify defects based

on their BTI and hysteresis behavior, ultimately leading to a better physical understanding of these degradation mechanisms and improvement strategies for 2D device reliability. Our compact device simulator Comphy [1] describes charge capture and emission using nonradiative multiphonon theory, providing a common physical framework for modeling BTI and hysteresis. By using the Effective Single Defect Decomposition (ESiD) method [2] together with Comphy, we can extract the distributions of trap levels and structural relaxation energies from electrical measurements over different temperatures, gate biases and timescales. Comparing these distributions with charge-transition levels and relaxation energies for particular defect candidates from density functional theory (DFT) allows us to assess which microscopic defects can account for the observed instabilities. We demonstrate this approach for transistors combining the promising zipper 2D semiconductor Bi2SeO2 with its native high-κ oxide β-Bi2SeO5 [3]. The measured dependence of the hysteresis on sweep frequency and temperature is reproduced well by our charge-trapping model, while ESiD was used to resolve the associated defect distribution [4]. Comparison with DFT identifies oxygen vacancies and oxygen interstitials in the oxide as likely microscopic causes of BTI and hysteresis [5]. These results link device degradation to specific defect candidates and provide a basis for improving oxide growth and interface processing in this material system. More broadly, the combined use of Comphy, ESiD, and DFT offers a systematic way to assess and improve the reliability of 2D transistors.

06 KEYNOTE

## 二维半导体的掺杂调控与高性能神经形态器件

**Kai Liu 刘锴**

*Tsinghua University, China*

伴随着现代信息技术和人工智能的高速发展，半导体产业开启亚 10 nm 节点时代，纳米电子器件亟需突破算力和功耗瓶颈，满足多功能化和智能化的应用需求。开发具有低结构复杂性、高性能、多功能以及低能耗的神经形态纳米电子器件势在必行。二维纳米材料通过范德华界面作用形成，具有纳米级甚至原子级厚度、无悬挂键的表面和宽范围的带隙，有望突破物理极限产生变革性的器件原理和技术。在本报告中，报告人将介绍近年来在 MoS2、MoTe2 等二维范德华材料的掺杂调控和新原理神经形态器件等方面的探索工作。通过这些研究，有望为新型智能电子材料和器件的研发探索出新的思路。

06 KEYNOTE

## Controllable Synthesis of Two-Dimensional Metal Oxides

**Dechao Geng 耿德超**

*Tianjin University, China*

Two-dimensional non-layered metal oxides (2D NMOs) are promising for photocatalysis and advanced electronics owing to tunable electronic structures and active surfaces, which can be further tailored by oxygen vacancy engineering. However, wafer-scale atomically thin synthesis is challenging due to intrinsic isotropic bonding, and vacancy concentrations are thermodynamically constrained, limiting device applications. Here, we present an electrochemical passivation liquid metal printing strategy that regulates oxidation kinetics via galvanic coupling. Using aluminum foil as both a sacrificial anode and a high-surface-energy substrate enables self-limiting oxidation and, with 13.8° wetting, produces wafer-scale uniform α-Bi2O3 films in air with thickness down to 0.7 nm. The ultrathin α-Bi2O3 enables photocatalytic degradation with 98.6% efficiency and good cycling stability. Building on this large-area ultrathin synthesis, we further present electron-induced liquid metal printing that modulates interfacial electron donation through work-function differences and competitive oxidation, enabling programmable oxygen vacancy concentrations in Bi2O3-x from 15.0% to 48.7%. The resulting films enable memristors with a 1.5 × 104 switching ratio, retention over 104 s, and endurance over 4 × 103 cycles, and a biometric decoder with 99.9% fingerprint recognition accuracy.

07 KEYNOTE

## 二维半导体晶体管的单晶范德华栅介质原位集成

**Xidong Duan 段镶锋**

*Hunan University, China*

*Abstract not received at the time of printing.*

08 INVITED

## Interfacial Modulated van der Waals Heterostructures and Intelligent Optoelectronic Applications

**Shoujun Zheng 郑守君**

*Beijing Institute of Technology, China*

The ultrathin nature of two-dimensional materials endows them with novel optoelectronic properties absent in their three-dimensional counterparts, and these properties can be readily modulated by electric fields, light intensity, strain, surface functionalization and other approaches. The weak interlayer van der Waals forces enable precise stacking of diverse van der Waals heterostructures. By tuning the interfacial interactions, we can manipulate ferroelectric, ferromagnetic and optoelectronic physical properties. First, we achieve reversible phase transitions between layered and non-layered materials via electric-field-driven interfacial topological phase transitions in metallic two-dimensional materials. Furthermore, we design a variety of sandwich-structured van der Waals heterostructures. By modulating interlayer van der Waals interactions and interlayer charge transfer, we realize the control of sliding ferroelectricity and the development of multifunctional optoelectronic devices. In the graphene/parallel-stacked bilayer hexagonal boron nitride/graphene tunneling architecture, we discover that sliding ferroelectricity in parallel-stacked bilayer hexagonal boron nitride can strongly modulate the tunneling current. On this basis, we propose a sliding memristor rooted in the sliding ferroelectric effect. Multiple ferroelectric polarization states are observed in the graphene/γ-InSe/graphene structure, which further enables tunable bulk photovoltaic effects and real-time imaging in tunneling devices. For $ReSe_2$/hBN/$ReSe_2$ twist-resonant tunneling transistors, the peak-to-valley ratio of the device is regulated by the twist angle.

09 INVITED

## Towards Post-Moore Electronics: 2D Semiconductor Materials and Device Technologies

**Na Li 李娜**

*Dongguan Institute of Materials Science and Technology, CAS, China*

The relentless scaling of conventional silicon transistors is approaching fundamental physical limits, driving the pursuit of alternative material platforms for post-Moore electronics. Two-dimensional (2D) semiconductors, represented by monolayer transition metal dichalcogenides, exhibit atomic thickness, dangling-bond-free surfaces and superior electrostatic gate control, making them promising candidates for advanced flexible electronic systems. Our group has long been dedicated to the epitaxial growth, device fabrication, integration and applications of 2D semiconductors. Focusing on key technical bottlenecks in this field, we carry out systematic research to develop high-quality epitaxy and transfer techniques for 2D semiconductors, together with fabrication and integration strategies for high-performance devices.

10 INVITED

## 高介电、超薄单晶栅介质的创制及其二维电子器件

**Hua Xu 许华**

*Shaanxi Normal University, China*

*Abstract not received at the time of printing.*

11 INVITED

## Two-Dimensional Metallic Catalysts for Hydrogen–Electricity Conversion

**Xiaoqiang Cui 崔小强**

*Jilin University, China*

Electrocatalysts play a pivotal role in efficient hydrogen–electricity conversion, enabling hydrogen production through water electrolysis and electricity generation through fuel cells. Our research focuses on the rational design and controlled synthesis of two-dimensional (2D) metallic materials, particularly metallenes, for efficient electrocatalysis in both processes. This presentation will highlight recent advances in metallene-based catalysts for water splitting and fuel cell reactions, with an emphasis on atomic-scale structural and interfacial engineering. The key reactions include the hydrogen evolution reaction (HER), oxygen evolution reaction (OER), oxygen reduction reaction (ORR), and hydrogen oxidation reaction (HOR). By incorporating lattice hydrogen, constructing atomically thin core–shell structures, and engineering oxygen vacancies, we have precisely modulated the local atomic configurations and electronic structures of 2D metallic catalysts to enhance their catalytic performance. Combining experimental investigations with theoretical calculations, we have elucidated the underlying structure–activity relationships and identified key factors governing catalytic activity and reaction mechanisms.

12 ORAL

## A Family of Ultrathin Non-van der Waals Kamiokite-Type Oxides for Two-Dimensional Electronics

**Run Shi 石润**

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13 KEYNOTE

## Van der Waals Layered MoSi2N4 Materials Family

**Wencai Ren 任文才**

*Institute of Metal Research, CAS, China*

2D materials, such as atomically thin graphene, hexagonal boron nitride and transition metal dichalcogenides, are normally limited by the known 3D bulk materials. The design and synthesis of entirely new 2D materials, particularly van der Waals (vdW) layered materials, would significantly expand the properties and functionalities of 2D materials. In 2020, we proposed a general concept to synthesize new 2D vdW layered materials by passivating the dangling bonds of 2D nonlayered crystals with appropriate elements [1]. Building on this concept, we developed a chemical vapor deposition (CVD) method to grow nonlayered 2D transition metal carbides/nitrides with diverse structures [2]. Interestingly, during the CVD growth of 2D molybdenum nitride, the introduction of elemental silicon was found to effectively passivate the surface dangling bonds, leading to the formation of a new vdW layered material, MoSi2N4 [1]. Monolayer MoSi2N4 exhibits p-type semiconducting behavior with a bandgap of ~1.94 eV, a high theoretical carrier mobility of up to 1200 cm2/Vs, outstanding mechanical strength (~66 GPa), good thermal conductivity (~173 W/mK), and excellent ambient stability [1,3]. Density functional theory calculations further predicted a large family of MoSi2N4-structured 2D layered materials with the general formula MA2Z4 [1]. Moreover, wafer-scale growth of monolayer MoSi2N4 and WSi2N4 single crystals has been realized recently [4]. To date, over a hundred MA2Z4 materials and their derivatives have been predicted, encompassing metals, semiconductors, superconductors, topological insulators, ferroelectrics, and ferromagnets, due to the diversity of elements and structures in MA2Z4 [5]. Such materials exhibit a variety of novel electronic, optical, thermal, mechanical, ferroelectric, electric contact, magnetic and spin-valley properties, as well as promising applications in electronic and optoelectronic devices, electrocatalysis, photocatalysis, and batteries [5]

14 KEYNOTE

## A Superconducting Diode with Altermagnetic Memory

**Weibo Gao 高炜博**

*Nanyang Technological University, Singapore*

Altermagnets combine vanishing net magnetization with momentum-dependent spin splitting, offering a distinct route to coupling magnetic order to superconductivity. Here we realize a van der Waals heterostructure by interfacing NbSe2 with KV2Se2O, whose surface hosts a d-wave altermagnetic electronic structure. Superconductivity remains essentially preserved, with the heterostructure exhibiting a transition temperature indistinguishable from that of the NbSe2 reference. Despite this preserved superconducting state, the heterostructure develops a field-free superconducting diode effect, revealing a finite superconducting polarity at zero applied magnetic field. Reversing the field-trained magnetic state reproducibly reverses the diode polarity, establishing a direct correspondence between altermagnetic order and nonreciprocal superconducting transport. By using the superconducting polarity as an electrical readout, we further identify a magnetic-state rewriting threshold between 175 and 185 K, above which the altermagnetic state becomes rewritable under opposite field cooling.

15 KEYNOTE

## 二维晶体与光学器件研究

**Kaihui Liu 刘开辉**

*Peking University, China*

光学晶体（如 BBO、KBBF、LiNbO3）具备实现激光频率转换、参量放大、信号调制、量子纠缠等关键功能，是激光技术和装备的核心。目前，基于传统体相光学晶体的物理理论和材料体系已臻于完善。二维材料因其超高非线性系数、光学性质外场易调、兼容硅基芯片等优点，是新一代光学晶体的理想候选。然而，二维材料的光与物质相互作用距离短，导致其非线性转换效率受限，难以成为真正有用的光学晶体。本报告将介绍我们在二维材料光学晶体的材料生长设计、物理理论发展、光学器件构造的一些思考和进展。发展出的转角二维材料光学晶体有望构建全新的光学晶体体系，开辟激光技术应用新领域。

16 KEYNOTE

## Wafer-Scale Synthesis and Application Exploration of Semiconducting Monolayer Transition-Metal Chalcogenides

**Yanfeng Zhang 张艳锋**

*Peking University, China*

Two-dimensional (2D) semiconducting transition metal dichalcogenides, most with a formula of MX2 (M=Mo, W; X=S, Se, etc.), have emerged as promising channel materials for next-generation integrated circuits. Wafer-scale preparation of Monolayer MX2 single crystal films, the epitaxial mechanism explorations through establishing some model porotypes should hold fundamental significances. [1-3] Herein, we report the first epitaxial growth of inch-scale monolayer MoS2 single crystals on Au(111) films and their high miller index facets, via an facile CVD method. By utilizing onsite scanning tunneling microscope (STM) characterizations combined with first-principles calculations, and other onsite characterization techniques, we have clarified the epitaxial mechanism from the viewpoints of adlayer-substrate lattice matching, interface coupling, substrate-step-edge guiding effect, etc., which resembles largely to the traditional epitaxial theory. [3] More intriguingly, we have also made significant progresses on the inch-scale preparation of Au(111) signal crystals and their vicinal facets, and other low-symmetry Au single-crystal substrates like Au(101). We have also accomplished the growth of mono-oriented monolayer MoS2 striped patterns to reconfirm the step-edge guiding effect [4], and demonstrated their potential applications in electronic devices and high efficiency hydrogen evolution reactions. [4,5] The direct preparation of 4-inch scale Au(111) thin films from commercial Au foils, and the growth of monolayer MoS2 or WS2 single crystals by using Mo(W)/Au(111)-surface-alloy-precursor-assisted

CVD route is also realized, and a substrate-step-edge-metal-atom-segregation mediated growth mode is also proposed[6]. Briefly, these continuous efforts should propel the understanding of the surface growth mode, epitaxial growth mechanism, and cross-scale characterizations of wafer-scale monolayer MX2 single crystals, low-cost production of Au(111) single crystals, etc. A homo-metal-element mediated surface modification route is also developed on industrial compatible sapphire substrate, for robust epitaxy of wafer-scale single-crystalline 2D semiconductors. [7]

17 KEYNOTE

## Filled Carbon Nanotube Ternary Transistors

**Lixing Kang 康黎星**

*Suzhou Institute of Nano-Tech and Nano-Bionics, CAS, China*

As circuit integration continues to advance, power consumption has become a critical bottleneck limiting further development. Multi-valued logic (MVL) has garnered extensive attention due to its potential to reduce interconnect complexity and switching losses. Single-walled carbon nanotubes (SWCNTs), with their superior electrical properties, ultra-small dimensions, and controllable aligned array growth, offer unique advantages for the large-scale fabrication of high-density MVL circuits. However, progress in this field using SWCNTs remains relatively lagging compared to two-dimensional materials, primarily due to device stability issues arising from challenges in precise doping control. Here, we demonstrate a system consisting of acetylacetonate metal molecules encapsulated within SWCNTs, in which carrier concentration can be dynamically modulated under an applied electric field. Transistors based on this platform validate that this electric-field-controlled modulation yields three well-defined logic states: 0,1, and 2. These transistors demonstrate good uniformity and stable operation, showing a static power consumption of 8.2 pW and dynamic power consumption of 0.31 nJ (state 0 to 1) and 0.35 μJ (state 1 to 2). The ternary inverter based on this heterostructure exhibits rail-to-rail output capability, enabling the accurate execution of MVL operations.

18 KEYNOTE

## Atomic-Scale Imaging and Control of Formation Pathways and Interface Evolution in Two-Dimensional Materials

**Rongming Wang 王荣明**

*University of Science and Technology Beijing, China*

Understanding how two-dimensional (2D) materials nucleate, grow, and form heterogeneous interfaces requires direct access to dynamic processes occurring across multiple spatial and temporal scales. These processes involve atomic migration, structural rearrangement, metastable intermediates, and interface reconstruction, which collectively determine the final crystal structure, interfacial configuration, and functional properties. However, conventional ex situ characterization generally captures only the final states and therefore provides limited information on the transient pathways that govern structural selection. In this talk, I will present our recent efforts to visualize and understand the formation pathways of 2D materials and metal–2D semiconductor heterostructures at the atomic scale by combining in situ environmental transmission electron microscopy, aberration-corrected imaging, quantitative image analysis, and multiscale theoretical calculations. In particular, direct atomic-scale observations of $MoS_2$ chemical vapor deposition reveal a multistep nucleation pathway involving two-dimensional amorphous precursors, layered disordered intermediates, and subsequent crystalline nuclei, highlighting a pathway beyond the conventional classical nucleation picture. Related studies further uncover the migration, aggregation, oriented nucleation, crystallization, and interface reconstruction of metal atoms, clusters, and nanoparticles on 2D semiconductor surfaces, revealing how interfacial interactions, strain, gaseous environments, and local atomic configurations regulate structural evolution. The integration of quantitative microscopy with artificial-intelligence-assisted image analysis further enables efficient extraction of atomic trajectories, local ordering, and structural transition signatures from complex dynamic datasets.

These studies demonstrate that the final structure of low-dimensional materials is governed not only by thermodynamic stability, but also by nonequilibrium formation pathways and kinetic intermediates.

19 KEYNOTE

## Unconventional Ferroelectricity at Two-Dimensional Limit

**Fucai Liu 刘富才**

*University of Electronic Science and Technology of China, China*

Ferroelectric material featuring its bi-stable states which can be switched by external electric field, has shown potential applications in nonvolatile memory, and neuromorphic computing. For the conventional oxide ferroelectric materials, especially whose thickness comes to a few unit cells, the notable depolarization effect and intrinsic size effect dominate, leading to the vanishing of the ferroelectric polarization. The rising of two-dimensional van der Waals materials provide a new opportunity for ferroelectricity study. Here, we reported new ferroelectricity discovered at the van der Waals interface of 2D materials. We observed anomalous intermediate polarization states, and the fatigue-free nature in 3R MoS2 sliding ferroelectricity.

20 KEYNOTE

## 先进超快电子显微镜研制及应用

**Xuewen Fu 付学文**

*Nankai University, China*

超快电子显微镜结合了电子显微镜的超高空间分辨率和飞秒激光的超快时间分辨率，可在超高时空尺度观测物质的形貌、结构、电荷、磁畴等微观动力学过程，成为物质科学微观动力学研究的重要手段之一。本报告首先介绍超快电子显微镜技术的研究背景、发展历程与研究现状；随后将重点介绍我们近年来在新一代先进超快电子显微镜研制及科学研究应用方面取得的进展，包括：新一代场发射超快透射电子显微镜、超快扫描电子显微镜-超快阴极荧光联合系统、场发射超快洛伦兹电子显微镜的研制，以及基于这些自主仪器平台在飞秒-纳米尺度半导体表界面光生电荷动力学可视化、飞秒-原子尺度低维关联电子体系光致 Peierls 畸变与莫特相变动力学、以及飞秒-纳米尺度光致拓扑磁相变及拓扑自旋手性相干翻转动力学等方面取得的进展。最后，报告将对超快电子显微镜技术的发展和应用进行总结和展望。

21 INVITED

## Ultrafast Growth of Two-Dimensional Single Crystals via Oriented Attachment on a Molten Surface

**Lin Li 林立**

*Peking University, China*

Two-dimensional (2D) materials offer substantial potential for next-generation electronic and optoelectronic devices, yet realizing their exceptional properties requires large-area single crystals. Their growth critically depends on interfacial control of nucleation, precursor diffusion, and crystallization. For compositionally complex 2D materials, coupled precursor transport and surface reactions further complicate growth, making the controlled synthesis of large-area single crystals a major challenge. Here, we introduce oriented attachment to the synthesis of complex 2D single crystals for the first time. By forming a molten precursor phase and tuning the nucleation density and rotational energy barriers of surface crystallites, we induce orientationally aligned collisions and rapid coalescence into large-area single crystals. This strategy enables rapid growth of monolayer rare-earth oxychloride single crystals, increasing growth rates by one to two orders of magnitude. These crystals exhibit excellent dielectric properties and low surface and interfacial defect densities. In LaOCl/graphene heterostructures assembled by layer transfer, graphene mobility increases by an order of magnitude to 31,000 cm2 V-1 s-1, with clearly resolved quantum Hall plateaus and Shubnikov-de Haas oscillations. The strategy extends to diverse material systems, including CoO, Co3O4, RbCa2Nb3O10, Rb3Nb11O30, CaNb2O6, SmTe2ClO5, and high-entropy niobates.

22 INVITED

## 二维金属间化合物和高熵金属合金的吸附-转化制备

**Peng Zhang 张鹏**

*Beihang University, China*

二维（2D）金属间化合物（IMCs）及高熵金属合金（HEMAs）因其涌现的物理性质和潜在的互连应用而备受关注。然而，二维 IMCs 和 HEMAs 固有的热力学不稳定性和动力学不可控性，使其单晶合成面临重大挑战。这里，我们报道了基于熔体的吸附-转化策略[1-3]，用于普适合成多种大尺寸超薄二维 Fe、Co、Ni、Cu、Pd 基 IMCs 和 HEMAs 单晶。在生长过程中，表面吸附物分解的金属原子嵌入金属基体中，同时吸附在表面的 Cl 原子通过增大各晶面间的能量差异，在动力学上驱动二维结构形成。所得材料电导率高达 $3\times10^{7}$ S $m^{-1}$，电阻-温度系数低至 2 ppm/K。该策略解决了二维 IMCs 和 HEMAs 单晶合成瓶颈，并为其涌现的物理性质及在纳米尺度互连线中的应用研究提供通用的材料平台。

23 INVITED

## Controllable Synthesis and Quantum Property Modulation of Two-Dimensional Intercalation Superlattices

二维插层超晶格的化学合成与量子物性调控

**Jingyuan Zhou 周劲媛**

*Nankai University, China*

Constructing two-dimensional (2D) intercalated superlattices via intercalation chemistry can preserve the host's intrinsic structure, offering a powerful pathway to tailor quantum properties and create new functional materials. This technique embeds functional molecules/ions into van der Waals gaps, combining layered host properties with guest molecular designability. The induced interfacial charge transfer, orbital coupling and electrostatic interactions modulate electronic and optical responses to produce emergent quantum states. Guided by programmable intercalation modulation, we established multiple strategies to engineer 2D quantum properties. Electrochemical intercalation yields "bulk-monolayer" MoS2 superlattices with enhanced direct-bandgap photoluminescence and preserved circular polarization. A two-step intercalation–cation exchange method realizes room-temperature ferromagnetism and exotic quantum states in 2D systems, while molecular engineering stabilizes the room-temperature commensurate charge density wave (CCDW) phase of 1T-TaS2. Our universal intercalation-exfoliation self-assembly approach synthesizes more than 50 types of 2D superlattices with tunable magnetism, chirality and superconductivity.

24 INVITED

## Kinetic Acceleration of MoS2 Growth by Oxy-Metal-Organic Chemical Vapor Deposition

**Lei Liu 刘蕾**

*Suzhou Laboratory, China*

Kinetics determines the growth behavior of thin films, particularly for atomically-thin transition-metal dichalcogenides. Metal-organic (MO) chemical vapor deposition (CVD) offers promise for scalable growth, but the reactions are kinetically limited, leading to nanometer-scale domain size and carbon contaminations. Here, we unveil the fundamental kinetic limitations and overcome them by introducing oxygen-assisted MOCVD (oxy-MOCVD) technology. By tuning reactions with oxygen, MO precursors are converted into high-purity transition-metal oxides and chalcogens, producing aligned MoS2 domains whose size and growth rate are orders of magnitude larger than conventional MOCVD. The MoS2 is free of carbon impurities and exhibits average mobility exceeding 100 square centimeters per volt per second.

25 INVITED

## Electronic Structure Regulation of Two-Dimensional Heterointerfaces for Efficient Electrocatalytic Water Splitting

**Tianyu Xia 夏田雨**

*Zhengzhou University, China*

The gas evolution reaction in water electrolysis is constrained by both interfacial mass transfer and charge transport, with bubble adhesion, interfacial charge accumulation, and competitive $Cl^-$ adsorption in seawater being key limiting factors. This report focuses on electronic structure regulation and mass transfer optimization of two-dimensional (2D) material heterointerfaces and presents three progressive studies: constructing a $MoS_2/NiSe_2$/CC hierarchical heterostructure array, which uses 2D layered channels for bubble release and oxyanions to repel $Cl^-$, while a work function difference drives a built-in electric field to promote charge transfer; proposing a space-confined selenization strategy to combine highly active $(CoFe)Se_2$ with multi-site (CoFe)-N-C, simultaneously improving the quality and quantity of active sites within the 2D N-C confined layer; and constructing a CoFeP@CoFe-N-C pre-catalyst that forms a $PO_4^{3-}$/CoFeOOH interface via in situ reconstruction, activating lattice oxygen and repelling $Cl^-$, thereby significantly enhancing stability under alkaline and seawater conditions.

# 分论坛七

SYMPOSIUM 07 · GRADUATE STUDENT FORUM

研究生论坛

07

AI EMPOWERMENT · MATERIALS INNOVATION · INTELLIGENT MANUFACTURING

01 INVITED

## Serving National Strategic Needs, Promoting the Exchange of Innovative Basic Research Achievements — Building and Introducing the Journal Fundamental Research

**Can Liu 刘灿**

*National Natural Science Foundation of China, Science Communication and Achievement Transformation Center*

本报告围绕国家基础研究发展战略，介绍国家自然科学基金委英文刊 Fundamental Research 的建设实践与发展布局。期刊坚持“四个面向”，聚焦数理、化学、生命、地球、材料、信息、医学等基础学科及前沿交叉方向，重点刊发高水平原创基础研究成果。报告系统梳理期刊在选题策划、重大成果组织、编委建设、学术质量管控、成果传播推广等方面举措，阐述期刊服务基金项目成果发布、搭建国内外学术交流桥梁的定位，分析当前建设面临的机遇与挑战，展望期刊持续提升国际话语权、支撑基础研究高质量创新、服务科技自立自强的发展路径。

02 INVITED

## Manuscript Selection: Perspectives from SCIE Senior Editors

**Wen Ma 马雯**

*Youke Publishing Co., Ltd., China*

Grounded in the important mission of international scholarly journals, this presentation summarizes the underlying logic and practical experience of manuscript evaluation from the standpoint of a practicing senior editor. Based on workflows spanning initial screening, peer review administration, and typical editorial decision cases, this talk elaborates on evaluation metrics for research originality, scientific robustness, logical consistency, and international significance, and further identifies common pitfalls in submitted manuscripts. Special focus is placed on AI-assisted writing and AI-generated content, including acceptable usage boundaries, associated academic ethics rules, compliant practices for AI tool adoption, mandatory disclosure requirements, and potential risks of academic misconduct.

03 INVITED

## Publishing in Wiley Materials Science Journals

**Bo Weng 翁博**

*Macromolecular Rapid Communications (Editor-in-Chief); Advanced Materials (Deputy Editor), Wiley*

日益严峻的科研竞争环境给科研人员带来了和以往相比更大发表论文的压力。本报告介绍了 Wiley 旗下材料类旗舰期刊的发展趋势和挑战，以及同行评议流程，编辑在处理稿件时着重注意的地方，如何选择合适的审稿人，如何应对审稿人的意见，以及在文章发表后如何获得足够的关注度和扩大文章的影响力等内容。

A highly competitive research environment with increasingly limited research funding has created a “Publish or Perish” attitude among scientists who are judged on the quantity rather than quality of their research articles. This presentation provides a brief overview of current trends and challenges in scientific publishing, some ethical considerations, how publishers and authors interact and influence each other, and how the publishing arena is being transformed. Tips will be presented on how to select an appropriate journal for your paper, what aspects of preparation and presentation to focus on from an editor’s and referee’s perspective, and hints for increasing the discoverability of your paper after publication.

04 ORAL

## Multiscale Interfacial Engineering for High-Performance Magnesium Batteries

**Kangjie Xu 许康杰**

*Nanjing Tech University, China*

Rechargeable magnesium batteries are promising candidates for next-generation energy storage owing to the abundance of magnesium resources, high volumetric capacity, and reduced tendency toward dendrite formation. However, their practical development remains hindered by sluggish reaction kinetics, interfacial incompatibility, and

insufficient reversibility of cathode reactions. This work explores multiscale interfacial engineering strategies involving cathode structures, functional separators, and electrolyte solvation to address these challenges. For sulfide cathodes, halide intercalation into CuS expands the interlayer spacing and weakens electrostatic interactions between Mg2+ and lattice anions, while a compatible borate-based electrolyte improves interfacial compatibility. For FeS2 cathodes, an in situ generated copper nanowire network establishes continuous conductive pathways, enabling reversible magnesium storage with a specific capacity of 679 mAh g–1 and an energy density of 714 Wh kg–1. In magnesium–sulfur batteries, a TiO2-TiN heterostructure-coated separator combines polysulfide adsorption with catalytic activity, suppressing polysulfide shuttling and accelerating sulfur redox reactions. This strategy delivers an initial discharge capacity of 1,588 mAh g–1 and increases the sulfur-mass-normalized energy density from 471 to 1,370 Wh kg–1. Furthermore, Fe-Nx single-atom catalysts incorporated into porous carbon separators promote polysulfide conversion and three-dimensional MgS deposition, achieving a second discharge plateau of approximately 1.32 V at an areal capacity of 5 mAh cm–2. Complementary electrolyte engineering through anion incorporation and mixed-solvent design further regulates Mg2+ solvation and improves interfacial charge transfer and reversible magnesium deposition and dissolution.

**05** ORAL

## Machine Learning-Assisted Low-Temperature Thermal-Force Coupling Carbonization of Customized Hard Carbon Microstructures Enables High-Performance Sodium-Ion Batteries

**Zongfu Sun 孙宗富**

*Tianjin University, China*

This work addresses the imbalance between ion-diffusion kinetics and reversible storage sites in carbon anodes for sodium/potassium-ion batteries. Two complementary routes are presented. First, oxygen-driven bulk-defect engineering and microcrystalline regulation of pitch-based carbon are proposed to control carbon-layer dimensions and defect density, enabling rapid potassium storage at low potential. Second, an artificial-intelligence-guided low-temperature synthesis of ideal hard carbon is developed: a data-driven model combining data mining with machine learning identifies the key microstructural descriptors (low specific surface area, moderate d002 spacing and moderate ID/IG), and a thermal-force coupled carbonization strategy then reproduces these target microstructures at markedly reduced carbonization temperature. The optimized hard carbon delivers 329.3 mAh g-1 with 87.4% initial Coulombic efficiency and 205.1 mAh g-1 at 2 A g-1, and Ah-level pouch cells achieve 221.5 Wh kg-1, 521.6 W kg-1 and 99.4% capacity retention over 600 cycles.

**06** ORAL

## Triple-Anchoring Binder for Improved Cyclability of Dry-Processed NCM811 Cathodes in Lithium-Ion Batteries

**Mengge Lyu 吕梦歌**

*Beijing Institute of Technology, China*

Dry-processed electrodes are promising due to solvent-free and low-cost features, but they are struggling with not only the limited mechanical properties of the binder, but also the intrinsic degradation of active materials. To simultaneously reinforce the binder and stabilize the crystal structure of LiNi0.8Co0.1Mn0.1O2 (NCM811) in a dry-processed cathode, a dynamic triple-drawing strategy is employed to design a triple-anchoring binder. A soft hyperbranched chain is introduced to achieve segmental drawing, crosslinking the crystalline domains of polytetrafluoroethylene and enhancing binder toughness. Lone-pair electrons on the binder functional groups create lattice-ion drawing by coordinating with the empty orbitals of surface transition-metal ions and drawing them away from cation mixing to achieve a more stable NCM811 lattice structure. The same Lewis-base sites also accomplish free-ion drawing, capturing the free transition-metal ions generated by HF corrosion and blocking their dissolution.

Consequently, the fracture energy of the binder increases by 62.74%, allowing it to better accommodate the mechanical strain and maintain electrode integrity. Dry-processed NCM811 cathodes fabricated with this binder retain 95.77% of their initial capacity after 100 cycles at 0.2 C and 80.19% after 450 cycles at 1 C.

06 ORAL

## Synthesis and Structural Design of Lithium Manganese Iron Phosphate (LFMP) Cathode Materials for High-Performance Lithium-Ion Batteries

高性能锂离子电池用磷酸锰铁锂（LFMP）正极材料的合成与结构设计

**Zhengyu Wei 韦政宇**

*Guangxi University, China*

This report focuses on the synthesis and structural design of lithium iron manganese phosphate (LFMP) cathode materials for high-performance lithium-ion batteries. LFMP has emerged as a research hotspot due to its high safety, relatively high energy density, and environmental friendliness. However, its intrinsic drawbacks, such as poor electronic conductivity and slow lithium-ion diffusion, hinder its practical application. The report systematically reviews various synthesis methods for LFMP (e.g., high-temperature solid-state, solvothermal methods) and their impact on material properties. Regarding modification strategies, it elaborates on key approaches: crystal facet engineering to expose highly active planes, ion doping to optimize the lattice structure, and constructing three-dimensional conductive networks (e.g., using MXene, carbon nanotubes, or biomass carbon) to synergistically enhance electron/ion transport. The research from our group demonstrates specific optimization pathways. First, by employing a mixed solvent system of Ar-$H_2$ nanobubble water (NBW) and ethanol, we effectively suppressed particle agglomeration and $Fe^{2+}$/$Mn^{2+}$ oxidation during synthesis. The resulting LFMP@C material exhibited enhanced structural integrity and interfacial stability, leading to significantly improved electrochemical performance. Second, we innovatively utilized corn stalk as a biomass carbon source to construct a continuous, porous, and wrinkled carbon layer on LFMP particles, forming a 3D conductive network. The prepared LFMP@Cornstalk-C composite delivered a high capacity retention of 94% after 500 cycles at 1C rate, along with excellent rate capability and lower interfacial impedance. In conclusion, the report proposes an integrated material design strategy—encompassing solvent engineering, crystal facet control, and conductive network construction—to synergistically improve the overall performance of LFMP materials, providing a feasible research direction for their high-safety, high-performance, and large-scale application.

07 ORAL

## Surface Modification of Li3InCl6 Provides Superior Electrochemical Performance for Lithium-Rich Manganese-Based Cathode Materials

**Guangdi Xu 许光迪**

*Guangxi University, China*

In this research, Li3InCl6 (LIC) coatings were prepared on the surface of Li1.2Mn0.54Co0.13Ni0.13O2 (LMRO) particles using a liquid phase method. Compared with 0LIC@LMRO, 2LIC@LMRO exhibits better electrochemical performance. After 150 cycles at 1C, the capacity retention rate of 2LIC@LMRO (87.31%) was 6.03% higher than that of 0LIC@LMRO (81.28%).

08 ORAL

## Non-Entangled Chains Enable Rapid Na+ Transport Through Ion-Traps in Gel Polymer Electrolytes at Low Temperatures

**Cheng Huang 黄成**

*Taiyuan University of Technology, China*

Polymer electrolytes are promising for all-climate rechargeable batteries due to their safety and compatibility with high-energy-density battery systems. However, topological traps induced by chain entanglement become a major transport bottleneck limiting continuous ion motion and interfacial charge transfer as temperature and liquid-phase content decrease. Here, we unveil that temperature-dependent ion-traps in the entangled gel polymer are a key factor for slow Na+ transport at low temperatures. Specifically, we propose a low-temperature-tolerant gel polymer electrolyte, denoted as non-entangled poly(1,3-dioxolane) (NPDOL), which promotes sodium bis(trifluoromethylsulfonyl)imide (NaTFSI) dissociation and provides homogeneous coordination sites for continuous Na+ transport. Meanwhile, the non-entangled, high-entropy polymer framework decreases chain relaxation time and expands free volume, thereby reducing the density of ion-traps and enhancing Na+ diffusion kinetics. Furthermore, reduced ion-trap density improves the Na+ transference number (tNa+ = 0.85), resulting in a thin and uniform solid electrolyte interphase (SEI) with improved interfacial Na+ charge-transfer. The NPDOL electrolyte exhibits high ionic conductivity (σ) of 0.25 mS cm−1 at -50 ◦ C, enabling Na//NPDOL//Na3V2(PO4)3 full cells to deliver nearly 100% capacity retention at -40 ◦ C.

09 ORAL

## Ir-Based Catalysts for Efficient PEMWE Hydrogen Production

**Xuansheng Wang 王暄胜**

*Taiyuan University of Technology, China*

Ir-based catalysts are the benchmark for the oxygen evolution reaction (OER) in proton exchange membrane water electrolysis (PEMWE), yet their activity and stability remain constrained by the trade-off between reaction intermediates and structural degradation. Defect engineering, surface reconstruction, heteroatom doping and support engineering are explored as the main strategies to break this trade-off. In this work, IrO2 was loaded by a hydrothermal route onto Ti-doped and regulated WO3·H2O supports. X-ray photoelectron spectroscopy shows that the W6+ feature shifts to higher binding energy while the Ir4+ features shift to lower binding energy after loading, indicating strong electronic interaction between the iridium oxide and the TiWO3·H2O support; the O 1s spectra are resolved into metal-oxygen bond, oxygen-vacancy and surface hydroxyl components. The resulting catalyst requires an overpotential of only 246 mV at 10 mA cm-2 with a Tafel slope of 65 mV dec-1, and shows no significant overpotential increase after 150 h of operation. PEMWE single-cell tests further identify the optimal slurry formulation, ionomer concentration and hot-pressing conditions.

10 ORAL

## Synergistic Engineering of Single Atoms and Defects for Selective Photocatalytic Oxidation of Methane to Value-Added Chemical Products

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Selective photocatalytic oxidation of methane with molecular oxygen offers a promising route to value-added oxygenates. Achieving high activity and selectivity requires coordinated utilization of photogenerated electrons and holes for reactant activation, together with controlled intermediate conversion and product release. This presentation explores the synergistic engineering of single atoms and defects as a strategy for connecting charge-carrier transport with selective surface chemistry. In TiO2, atomically dispersed Pd and gradient-distributed Ti3+ species are integrated

to enhance electron and hole transport cooperatively. Pd single atoms facilitate electron transfer and O2 activation, while the Ti3+ gradient promotes hole migration from the bulk to the surface for CH4 activation. Their cooperation enables a C1 oxygenate production rate of 8.14 mmol gcat−1 h−1 with 91.3% selectivity at room temperature, demonstrating the importance of simultaneously improving both charge-carrier pathways. Building on this principle, isolated Zn atoms are anchored on oxygen-deficient WO3 to construct adjacent Zn−O−W−Ov ensembles for selective formaldehyde production. The Zn−O−W unit promotes CH4 adsorption and hole-mediated C−H cleavage, whereas neighboring oxygen vacancies facilitate O2 adsorption and electron-driven reduction. Spectroscopic investigations and theoretical calculations support a methoxy-mediated pathway toward formaldehyde. Thermal assistance further promotes intermediate conversion and formaldehyde desorption, helping suppress consecutive oxidation. With only 0.02 wt% Zn, this noble-metal-free catalyst achieves a formaldehyde production rate of 8.96 mmol gcat−1 h−1 with 90% selectivity at 150 °C. Together, these studies show how complementary functions of single atoms and defects can be coordinated across charge transport, reactant activation, and subsequent surface reactions.

**11** ORAL

## Steering Intermediate Adsorption with Dual-Site PtMo/C Catalysts for Efficient Alkaline Hydrogen Evolution

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Alkaline hydrogen evolution on Pt is limited by sluggish water dissociation and by excessive OH* coverage that blocks the Pt sites. A dual-site PtMo/C catalyst is therefore designed so that H* and OH* adsorb on separate sites, reducing competition for Pt, while Pt-Mo electronic interaction tunes the intermediate adsorption energies. The catalyst is prepared by an adsorption-annealing route and verified by XRD, TEM and EDS, which indicate Mo-Pt interaction and homogeneous elemental distribution on the carbon support. In situ Raman spectroscopy supports OH* adsorption on Mo sites and H* adsorption on Pt sites. The catalyst delivers overpotentials of 10 mV at 10 mA cm-2 and 292 mV at 1 A cm-2, and the assembled PtMo/C || NiFe(Se)OH-BO AEM electrolyzer reaches 1 A cm-2 at 1.71 V at 60 °C, pointing to a practical route for low-precious-metal alkaline water electrolysis.

**12** ORAL

## Parallel Microfluidic Synthesis of High-Entropy Alloy Nanoparticles: High-Throughput Preparation and Hydrogen Electrocatalysis

高熵合金纳米颗粒的并行微流控合成：高通量制备与析氢电催化

**Xinhang Ma 马新航**

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This study investigates the synthesis of high-entropy alloy nanoparticles and their application in hydrogen evolution through the following work: (1) We develop an eight-channel parallel microfluidic platform and prepare a total of 108 distinct compositions of high-entropy alloy nanoparticles under mild conditions. (2) We combine structural characterization with molecular dynamics simulations to investigate alloy formation and the nanoparticle formation process. (3) Using PdPtCrMnFe as a representative alloy, we evaluate its hydrogen evolution performance in acidic media and explore the surface hydrogen spillover mechanism through density functional theory (DFT) calculations. (4) We conduct proton exchange membrane water electrolysis tests at 1 A $cm^{-2}$, achieving stable operation for over 500 hours. 摘要：本研究围绕高熵合金纳米颗粒的制备与析氢应用开展以下工作： （1）建立八通道并行微流控平台，在温和条件下共制备了 108 种高熵合金纳米 颗粒。 （2）结合结构表征与分子动力学模拟，研究颗粒的合金化特征及形成过程。 （3）以 PdPtCrMnFe 为代表，评价酸性析氢性能，并通过 DFT 计算探讨表面氢 溢流机制。 （4）在 1 A $cm^{-2}$下开展质子交换膜水电解测试，实现超过 500 h 的稳定运行。

13 ORAL

## Biaxial Strain-Engineered Pt-Sulfur Vacancy Dual Active Sites in Pt/MoO2@MoS2 Architectures for pH-Universal Hydrogen Evolution

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Developing high-performance pH-universal hydrogen evolution reaction (HER) catalysts is severely hindered by the conflicting kinetic requirements of proton reduction in acidic media and sluggish water dissociation in non-acidic environments. Here, we report an interfacial engineering strategy to construct Pt decorated core-shell MoO2@MoS2 (Pt/MoO2@MoS2) architectures featuring biaxial-strain-regulated Pt-sulfur vacancy (Sv) dual active sites to overcome these barriers. The catalyst exhibits ultralow overpotentials of 36, 60, and 74 mV at 10 mA cm-2 in acidic, alkaline, and neutral media, respectively, along with outstanding long-term stability (sustaining at least 1000 hours of continuous operation at 100 mA cm-2 in acids). Combining with density functional theory calculations, we reveal that interfacial strain facilitates Sv formation and, together with Sv, synergistically stabilizes Pt anchoring. Within this architecture, Pt clusters serve as the primary active centers for H* adsorption in acids and dominate the H2O adsorption/dissociation processes in alkaline/neutral environments. Crucially, the adjacent Sv sites act as dedicated desorption channels, facilitating hydrogen migration and recombinative release across the broad pH range. This synergistic configuration optimizes the HER pathway by preventing the excessive occupation of Pt sites, thereby ensuring rapid kinetics and exceptional performance.

14 ORAL

## Highly Sensitive All-Polymer Short-Wavelength Infrared Photodetectors for Complementary Metal Oxide Semiconductor Integrated Imaging Enabled by Dual-Acceptor n-Type Polymers

**Yupu Wang 王玉璞**

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Short-wavelength infrared (SWIR) organic photodetectors (OPDs), particularly all-polymer ones, hold substantial commercial promise in vital monitoring and imaging. However, the development of all-polymer SWIR OPDs has been limited by lack of high-performance n-type ultralow-bandgap polymer semiconductors. Herein, we report two dual-acceptor polymers (ThDPP-CNBTz and ThDPP-CNBSz), with dicyano-benzothiadiazole/benzoselenidazole as strong acceptor units, diketopyrrolopyrrole as a sub-strong acceptor unit, and thiophene as a donor moiety. Both polymers possess ultralow optical bandgaps and deep HOMO/LUMO, making them ideal acceptor materials for all-polymer SWIR OPDs. Owing to more efficient charge generation and transport, ThDPP-CNBTz-based all-polymer OPDs show superior responsivity ≥ 0.160 A W-1 from 950 to 1,050 nm. The ThDPP-CNBSz-based OPDs show lower noise currents, attributed to the larger thermal activation energy of dark current and lower trap density. As a result, ThDPP-CNBTz- and ThDPP-CNBSz-based OPDs deliver similar specific detectivity, exceeding 1012 Jones in spectral range of 780 – 1140 nm and 350 – 1,240 nm, respectively. Furthermore, ThDPP-CNBTz-based stretchable OPDs show a small performance attenuation after 1,000 cycles of stretching at 20% strain, heralding potential application in wearable vital monitoring.

15 ORAL

## Long-Focal-Length Planar Focusing of Anisotropic Plasmons in Two-Dimensional MoOCl2/Au Heterostructures

二维 MoOCl2/Au 异质结构中各向异性等离激元的长焦距平面聚焦

**Jianqiao Zhao 赵鉴侨**

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双曲极化激元能够突破传统光学衍射限制，为亚波长尺度下的光场调控和片上光子器件提供重要平台。然而，现有双曲极化激元研究主要集中于中红外和太赫兹波段，在可见光频率下，其平面聚焦仍受到长程传播与强场压缩之间权衡关系的限制，难以同时实现长焦距和亚波长焦斑。针对这一问题，本工作构建了二维各向异性材料 MoOCl2 与 Au 超构表面的异质结构，利用 MoOCl2 的面内双曲色散特性对 Au 薄膜的表面等离激元进行波前重构，实现了可见光频率下各向异性等离激元的长焦距亚波长平面聚焦。 基于透射式扫描近场光学显微镜（SNOM）和定量近场分析，我们在 633 nm 激发下实验验证了 MoOCl2/Au 异质结构中的平面聚焦行为。优化后的 40 nm MoOCl2 样品实现了约 2.5λ的焦距和约λ/5 的焦斑半高宽，并获得约 3 倍的焦点能量增强。该结果为非接触式纳米探测、片上光互连和集成纳米光子器件提供了新的设计思路。

16 ORAL

## High-Performance Stretchable Composite Electrodes for Intrinsically Stretchable Organic Photovoltaic Cells and Sensors

**Dexia Han 韩德霞**

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Stretchable electrodes, with their indispensable applications in wearable electronics—including human–machine interfaces, flexible sensing systems, and wearable power supplies, have garnered substantial research interest. However, the current high-performance stretchable electrodes posed challenges for their large-scale application in the realm of flexible wearables due to the complicated and inefficient preparation methods. To reslove this need, a straightforward and effective embedding strategy is developed to fabricate stretchable silver nanowire/thermoplastic elastomer composite electrodes (referred to as Strem-AT), leveraging the viscoelasticity and outstanding mechanical properties of polymer elastomers to attain remarkable stretchability, conductivity, and a smooth surface. It has been demonstrated that these electrodes exhibit excellent tensile behavior, low surface roughness, and stable electrical properties. This renders them well-suited for integration into stretchable sensors and intrinsically stretchable organic photovoltaic cells (IS-OPV). Sensors based on Strem-AT demonstrated exceptional stretchability and consistent signal output for the monitoring of human joint motion. Furthermore, the all-polymer IS-OPV demonstrated a power conversion efficiency (PCE) of over 12.5%, as well as a PCE80% of more than 50%. Following 1000 cycles of 50% strain cycling, the IS-OPV retained 76% of its initial PCE.

17 ORAL

## Study on STE Properties of Lead-Free Cs2ZrCl6 Scintillators Regulated by Bi3+/Mn2+

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Lead-free zirconium-based halide scintillators are promising for X-ray detection and imaging owing to their structural stability, defect tolerance, and solution processability. Aliovalent doping can regulate the excited states of vacancy-ordered halide scintillators, but may also generate charge-compensating defects that promote nonradiative recombination. Here, Bi3+/Mn2+ co-doping is used to control the defect and excitonic states of vacancy-ordered Cs2ZrCl6. Bi3+ substitution induces local lattice distortion and introduces Bi3+-associated excitation and radiative-decay pathways, while simultaneously increasing the tendency for chloride-vacancy formation. Temperature-dependent photoluminescence, Raman spectroscopy, and thermoluminescence measurements show that Mn2+

redistributes the trap population, suppresses deep-trap-mediated losses, and stabilizes lattice-coupled self-trapped excitons. Density functional theory calculations support an interstitial Mn2+-based charge-compensation configuration that reduces the thermodynamic tendency for chloride-vacancy formation in the Bi3+-doped lattice. Consequently, the photoluminescence quantum yield increases from 34.8% to 84.12%, and the optimized scintillator exhibits a light yield of 56,840 photons MeV-1, a detection limit of 2.84 μGy s-1, and stable radioluminescence under continuous irradiation. A multilayer flexible screen further achieves a spatial resolution of 30 lp mm-1 and enables curved-surface and underwater X-ray imaging.

**18** ORAL

## Design and Performance of Mineral-Structured Luminescent Materials for Pressure Sensing

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Accurate and reliable pressure monitoring is essential for deep-Earth, deep-sea, and space exploration, as well as major engineering applications. Optical manometry enables remote, noncontact, real-time monitoring through pressure-induced changes in luminescence and is a highly promising pressure measurement technique. Although conventional optical pressure calibration systems, exemplified by ruby, are widely used in high-pressure experiments involving diamond anvil cells, their limited sensitivity and susceptibility to temperature fluctuations hinder high-precision measurements under coupled pressure-temperature conditions. To address these limitations, we investigate local coordination control of luminescent centers and multichannel pressure sensing in mineral structures, exploring the coordinated optimization of structural design and optical readout. In Li4SrCa(SiO4)2: Eu2+, Eu2+ occupation of distinct Sr and Ca lattice sites produces two luminescent centers, enabling three pressure readout modes based on spectral shift, fluorescence intensity ratio, and full width at half maximum. The Ca-site emission exhibits a redshift sensitivity of 5.19 nm·GPa-1 in the low-pressure regime, approximately 14 times that of ruby; dual-mode detection using luminescence intensity and lifetime further expands the available pressure sensing approaches. In Cr3+-doped, coupled ionic substitution induces an ordered-to-disordered structural transition that weakens the local crystal field, followed by further optimization of lattice rigidity. The resulting CaSc0.6Al1.4SiO6: 0.01Cr3+ exhibits a reversible emission blueshift over approximately 0-7.5 GPa, with a spectral-centroid shift sensitivity of 15.08 nm·GPa-1, approximately 2.8 times that of the ordered counterpart and 41 times that of ruby, combining high sensitivity with a broad pressure range. To mitigate temperature interference, spectral and time-gated ratiometric strategies are introduced into Y3In2Ga3O12: Cr3+. Together with a stable local coordination environment, these strategies reduce the influence of temperature on pressure readout. The fluorescence intensity ratio and time-gated intensity ratio achieve maximum relative pressure sensitivities of approximately 43%·GPa-1 and 51%·GPa-1, respectively. The maximum thermal-invariance manometric factors for the two readout approaches reach approximately 7700 and 2500 K·GPa-1, respectively, demonstrating strong resistance to thermal interference.

**19** ORAL

## New Manufacturing Strategy of Thickening Pipe End by Surfacing Welding to Eliminate the Harmful Effect of Softened Zone in X80 Girth Welded Joint

**Zhendan Zheng 郑震旦**

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The softened zone in the heat-affected zone governs the failure of X80 pipeline girth welded joints. A new manufacturing strategy is proposed in which the pipe end is thickened by surfacing welding, so that the minimum average hardness along the thickness direction is transferred from the narrow weld toe to the thickened base metal. Systematic tensile, Charpy impact and hardness testing shows that the structural reinforcement at the weld toe shifts strain concentration away from the softened zone, increasing the ultimate tensile strength from 644 MPa to 695 MPa

(+51 MPa) and the elongation by 2.1%. A threshold condition is established: a surfacing thickness greater than 4.7 mm on the outer wall of the pipe end is required, with no requirement on the inner wall. In the base metal, heat-affected zone, surfacing welding zone and weld zone the phase constitution evolves as AF+PF (small amount)+M-A -> AF+PF (large amount)+M-A -> AF+M-A -> AF+M-A+GBF. The resulting joints satisfy the service requirements of API 1104-2021, and the strategy is verified by DIC strain mapping and full-scale tests.

20 ORAL

## Additive Manufacturing of Porous AlSi10Mg Material by Laser Powder Bed Fusion and Analysis of Pore Characteristics

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Additive manufacturing technology has become increasingly popular in many industrial fields due to its unique technical advantages for producing complex parts. Incorporating porous materials is an effective strategy for manufacturing parts with complex shapes and bending properties special properties while also meeting the need for lightweight components. Studies have shown that controlling the manufacturing process parameters can directly fabricate porous materials, but the underlying process basis of this method has not been clearly understood. In this work, an Laser powder bed fusion(LPBF) experiment was conducted using response surface methodology to fabricate AlSi10Mg porous materials. The influence of process parameters on porosity and was analyzed, and the mechanism that affects pore morphology was discussed to explain the reason for the formation of the pore structure. The response surface was created to demonstrate the correlation between processing parameters and porosity. The results show that the structure of AlSi10Mg porous material prepared by LPBF is mainly composed of lack of fusion(LoF) pores, which have good connectivity and uniformity. The instability of the molten pool caused by low energy input leads to balling and discontinuous defects, which provides an opportunity for the formation of LoF pores.

21 ORAL

## Biomimetic Kagome-Gyroid Interpenetrating Metamaterial for Tailoring Lightweight and Mechanical Performance

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This work presents a novel interpenetrating Kagome-Gyroid (K-G) structure designed to optimize lightweight, high-strength metamaterials. Inspired by natural biomimetic structures such as the microstructure of butterfly wings and cancellous bone, the K-G structure combines the shear resistance of the Kagome lattice with the high specific strength and stiffness of the Gyroid lattice. The optimized K-G structure demonstrates a 49.5% increase in specific energy absorption and a 35.6% improvement in energy absorption efficiency compared with conventional metamaterials, highlighting its potential for high-impact applications. Experiments and simulation results reveal that geometric parameters significantly influence failure and fracture behaviour, particularly affecting energy-absorption characteristics. The study also investigates the distribution patterns of surface roughness and internal defects during the laser powder bed fusion (L-PBF) manufacturing process, highlighting their potential impact on the mechanical performance of the final structure. This novel design provides a promising foundation for the development of advanced materials with superior energy absorption capabilities, making it ideal for high-impact applications in aerospace, rail transportation and automotive industries.

22 ORAL

## Local Dry Underwater TIG Welding for Repairing Spent Fuel Pool Walls

乏燃料水池壁面局部干法水下 TIG 焊接修复工艺研究

**Feihong Zhou 周飞鸿**

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核电站乏燃料池因长期服役，其底面与壁面的不锈钢覆板会产生裂纹、孔洞等缺陷，导致放射性液体的泄漏，对环境产生恶劣影响，影响核电站的安全运行。传统潜水员手工焊接或核电站停运维修都不能满足当下维修需求，局部干法自动水下焊接维修是发展趋势。与底面覆板水下焊接相比，壁面位置因排水存在压差并且熔池受重力影响更加明显，壁面覆板水下维修的焊接和排水工艺更难实施，很大程度上增加了修复难度。故本文对壁面覆板的局部干法排水和焊接工艺进行了探索和优化研究。 为模拟核电站乏燃料水池壁面覆板的水下维修，研制了一套局部干法水下钨极气体保护焊（TIG）焊接修复系统，主要包括移动定位机构、TIG 电源、水下 TIG 焊接排水装置、控制系统、送丝机、实验水池等。局部干法水下 TIG 焊接排水装置具有多位姿的高适应性，能够适用于壁面位置水下环境的焊接维修需求。 采用第二代核电站乏燃料水池覆板材料 304L 不锈钢，针对覆板壁面位置常见裂纹式、孔洞式缺陷，分别在壁面位置开展了 TIG 裂纹填丝密封堆焊与补板焊接修复工艺研究。维修实施流程主要包括：开启水下焊接排水装置内部补光灯与摄像头、开启保护气、水下焊接排水装置入水、双摄像头结合距离传感器定位、焊接开始、焊接结束、排水罩出水、关闭罩内保护气、关闭补光灯以及摄像头，通过优化各步骤之间的逻辑关系与配合方式，实现局部干法水下焊接远程自动化控制。 针对乏池覆板壁面位置立向位置微小裂纹缺陷，通过在 304L 不锈钢板原始对接焊缝位置预制宽度为 0.2mm 的裂纹，采用自下而上方向、侧送丝的 TIG 密封堆焊维修方式，开展 304L 不锈钢立向位置水下 TIG 填丝焊接一次成形、二次成形工艺试验。结果表明：两组焊缝成形后的预制裂纹均无大幅度扩展，其中一次成形余高较高、熔深较小；两组焊缝显微硬度均为焊缝区>熔合区>热影响区>母材，二次成形硬度较高；两组焊缝金属 Cr 元素含量升高增强了其耐腐蚀性能，二次成形耐腐蚀性能较高。二次成形相较于一次成形的修复效果更为理想，验证了水下填丝密封焊接的可行性。 针对乏池覆板壁面位置横向位置微小裂纹缺陷，通过在 304L 不锈钢板原始对接焊缝位置预制宽度为 0.2mm 的裂纹，采用前送丝的 TIG 密封堆焊的维修方式，开展 304L 不锈钢横向位置水下 TIG 填丝焊接一次成形、二次成形工艺试验。结果表明：两组焊缝成形后的裂纹无大幅度扩展，其中二次成形余高较高、熔深较深、裂纹近乎无扩展；显微硬度焊缝区>熔合区>热影响区>母材，二次成形显微硬度高于一次成形，且硬度最大值出现在羽毛状δ铁素体聚集处；两组焊缝金属中 Cr 元素含量提升增强了其耐腐蚀性能，其中二次成形耐腐蚀性能较好；二次成形焊接修复效果更为理想。 针对乏池覆板壁面位置大面积裂纹或孔洞式缺陷，采用尺寸为 80mm（长）x80mm（宽）x4（厚）mm 的方形补板结构形式，通过补板与乏池不锈钢覆板壁面原始焊缝待修复位置对正贴合，将补板焊接分解为两横向位置与两立向位置的焊接。分别开展了水下环境与空气环境中横向位置和立向位置的 TIG 填丝焊接工艺试验。并对两种环境下焊接接头进行组织与性能的对比分析，结果表明：水下环境因熔池快速冷却导致其焊缝截面尺寸略小于空气环境；水下环境δ铁素体含量与硬度高于空气中，并在羽毛状铁素体聚集处出现显微硬度最大值；水下环境焊缝晶粒尺寸略大于空气中，耐腐蚀性能略低于空气环境但相差不大，两环境下焊缝金属均析出 Cr 元素提升其耐腐蚀性能，证明水下补板修复焊缝的成形质量可与空气环境中制备的焊缝相媲美，达到乏池覆板壁面位置的修复效果。 研究结果为乏池壁面位置水下环境 304L 不锈钢板的缺陷（裂纹缺陷、孔洞式缺陷）维修奠定了良好的基础。

23 ORAL

## Synergistic Improvement of Microstructure and Properties of Laser-Arc Hybrid Welded Mg Alloy via Carbon Nanotubes and Oscillating Laser Beam

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As the ideal materials for lightweight applications, Mg alloys have been widely adopted in various high-end fields. Nevertheless, their poor weldability and inferior weld performance restrict their practical utilization. In this study, carbon nanotubes (CNTs) and oscillating laser beam were introduced during laser-arc hybrid welding to synergistically tailor the microstructure and properties of Mg alloy welds. The results show that CNTs tend to agglomerate in the high-viscosity molten pool, which deteriorates weld formation. The oscillating laser beam can stir the molten pool and

facilitate the dispersion of CNTs. Moreover, the oscillating laser beam can also eliminate pores and break dendrites. With the combined introduction of CNTs and oscillating laser beam, the average grain size of the weld decreased from 30.3 μm to 16.5 μm, and the texture intensity of the (0001) plane reduced from 9.34 to 3.17. Furthermore, the content of precipitates increased from 0.60% to 1.76%. The homogeneity of weld microstructure was greatly enhanced, and the coarse columnar grains near the fusion line were transformed into fine equiaxed grains. The tensile strength of the welded joint increased from 230 MPa to 252 MPa, the elongation rose from 10.2% to 13.3%, and the microhardness increased from 63 HV0.1 to 74 HV0.1. In addition, the corrosion resistance of the weld was significantly improved. The hydrogen evolution and weight loss corrosion rates decreased by more than 30%, and the corrosion current density dropped by 50%.

**24** ORAL

## Interface-Modulated Transition from {332} Twinning to Martensitic Banding in Metastable Ti-6Mo-3.5Cr-1Zr Alloy

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The combined introduction of stress-induced α' martensitic (SIMα') transformation and deformation twinning is critical in metastable titanium alloys for achieving high strength and superior work-hardening capability, but the mechanistic transition between these two deformation modes remains poorly understood. In this work, we systematically investigate the interaction between {332} twins and grain boundaries (GB) in metastable Ti-6Mo-3.5Cr-1Zr alloy, revealing two distinct accommodation modes. {332} twinning is activated in adjacent grains separated by low-angle GBs. With increasing misorientation angle, both SIMα' and {332} twinning become popular across GBs with similar misorientation angles. We further evaluate the displacement gradient accommodation ability of each candidate with respect to the GB misorientation angle and axis. When {332} twinning serves as the preferred candidate, the misorientation axis exhibits no dependence.

**25** ORAL

## Electrical Double Layer Dynamics Regulation for Maximized Electrostatic Energy Harvesting

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Distributed energy harvesting is highly desirable for powering the future Internet of Things. Water-solid triboelectricity could directly harvest electricity from interfacial interaction, converting energy from ubiquitous water motion, such as sweat, raindrops, and waves. The technique called as the liquid-solid triboelectric nanogenerator (LS-TENG), however, suffers from low energy conversion amount compared to the well-researched solid-solid triboelectric nanogenerators (SS-TENGs). We investigate the underlying reasons, revealing two interfacial charge-loss mechanisms associated with the dynamics of the electrical double layer (EDL). Targeted mitigation strategies are proposed accordingly. A switch-enhanced architecture achieves unprecedented average and peak power density over ultrawide resistance matching of 1 kΩ–100 MΩ. This unlocks previously inaccessible applications of LS-TENGs, as demonstrated by a droplet harvester producing ampere-level current output and a wave-energy harvester rivaling state-of-the-art SS-TENGs.

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## Multifunctional Lignin-Based Anticorrosive Coatings for Metal Protection

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This work focuses on the development of high-performance lignin-based waterborne epoxy (WEP) coatings to extend metal service life. Two innovative approaches were explored: (1) utilizing the quaternized sodium lignosulfonate (QLS) as a functional nanofiller; (2) synthesizing QLS-TiO2 nanocomposites for multifunctional WEP coating. The QLS/WEP coating maintained a high impedance modulus (2.29 x 10^6 ohm cm2) after 51 days in a high-salinity environment, owing to the adsorption of QLS on the carbon-steel surface and the formation of a protective film through sulfonate and quaternary ammonium groups. The QLS-TiO2 nanocomposites were further used to boost coating durability and weather resistance: combining the stability of TiO2 with the inhibitive effect of lignin, the QLS-TiO2/WEP coating showed excellent protection in acidic, alkaline and salt environments, and in acidic media the impedance modulus reached 5.81 x 10^7 ohm cm2, three orders of magnitude higher than commercial WEP. The nanocomposites also exhibited superior thermal stability and UV-shielding properties, improving coating weatherability. Both coatings harness the key multifunctional attributes of lignin - UV absorption, free-radical scavenging and corrosion inhibition - demonstrating the potential of lignin-based materials for sustainable metal protection in harsh industrial applications.

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## Direct Ink Writing and Multiscale Structural Design of Hybrid Aerogels for Advanced Thermal Management and Acoustic Meta-Devices

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Owing to their ultralow thermal conductivity and high specific surface area, aerogels hold broad promise in microelectronics thermal management, aerospace thermal protection, next-generation energy storage devices, and biomedical engineering. However, conventional aerogels are fundamentally constrained by their intrinsic brittleness, difficulty in processing complex geometries, and the limited performance of monolithic homogeneous architectures that fail to satisfy diverse application demands. To address these bottlenecks, this study proposes an autocatalytic gelation-assisted direct ink writing 3D printing method alongside a multiscale topological design strategy. By employing bis[3-(trimethoxysilyl)propyl]amine (BTPA) as the molecular precursor, an alcohol–water bath is introduced to trigger in situ autocatalytic hydrolysis and polycondensation, successfully yielding hybrid aerogels with both robust mechanical strength and superior thermal insulation. This approach offers multiple advantages, including operational simplicity, an eco-friendly formulation, and extended ink shelf life. Leveraging this versatile manufacturing strategy, engineering applications for thermal management and acoustic meta-devices were further developed. Specifically, ultrathin thermal insulation enclosures were integrally printed for heat-generating microelectronic chips, achieving highly efficient and precise localized thermal shielding. Furthermore, through the cross-scale integration of periodic honeycomb architectures and microperforated resonant cavities, the viscous dissipation of the nanoscale skeleton was synergistically coupled with macroscopic Helmholtz resonance, remarkably broadening the low-frequency sound absorption bandwidth.

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## Vacancy-Migration-Enabled, Two-Dimensional Gate-Free Neuromorphic Devices for High-Temperature Applications

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Due to the low carrier scattering and scale-down capability, two-dimensional (2D) materials are promising for building high-temperature neuromorphic electronics that are highly needed for performing complex tasks above 125 °C. However, current 2D high-temperature neuromorphic devices based on conventional resistive switching mechanisms still have key problems, e.g., severe gate leakage in three-terminal devices and a limited number of resistance states in two-terminal devices at high operating temperatures. Here, we report a gate-free, high-temperature MoS2 neuromorphic device with up to 256 tunable resistance states, representing the state-of-the-art resistance state number in a two-terminal device operating at high temperatures. In addition to the multi-state function, the device also has an enhanced resistive switching ratio of ~103 at 200 °C and simulates diverse synaptic plasticities at 350 °C. Such superior performance is enabled by Schottky barrier modulation through thermal-activated directional migration of sulfur vacancies. The device further demonstrates remarkable potential for high-temperature neuromorphic computing in handwritten digit recognition and reservoir-computing-based temporal data processing.

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## AI-Enabled Dynamic Analysis and Phase Transition Identification of Magnetic Skyrmion Lattices

人工智能赋能磁斯格明子晶格的动态解析与相变识别

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磁斯格明子是一类具有非平庸拓扑荷的纳米尺度磁结构，兼具拓扑稳定性、可电流操控、低能耗和类粒子集体行为等特征，被视为高密度、低功耗自旋电子与非常规计算的重要信息载体[1-4]。原位显微表征能够直接记录这些动态过程，但海量图像中的粒子位置、局域结构和相变路径难以依靠人工判读稳定提取，亟需自动化定量分析方法。 为此，我们首先将机器视觉用于斯格明子动力学过程，自动识别斯格明子并追踪轨迹、霍尔角、缺陷与曲率[3]。结果显示，斯格明子霍尔运动引起横向压缩，缺陷介导六角晶格重组为具有密度和尺寸梯度的共形晶格；逆共形映射恢复近六角有序，从几何上验证其共形性。该工作把图像转化为粒子级动力学数据，建立了“观测-识别-量化”的分析模式。 进一步地，我们将斯格明子提取为节点，以 Delaunay 三角剖分定义邻接关系，并把局域六重取向序及其梯度编码为图结构。随后采用等变图神经网络、Deep Graph Infomax 自监督学习和高斯混合模型构建无监督框架[4]。该方法无需预设相标签或人为阈值，即可生成节点分辨的动态相图并得出相分数，揭示斯格明子晶格固相-共形相转变过程，经历准液态中间阶段与位错瞬态增殖，随后通过局域重组形成稳定共形有序。机器视觉负责提取粒子级动力学信息，图神经网络进一步学习局域关联并识别相变路径，为 AI 赋能复杂拓扑磁结构的可解释表征提供了方法基础。
图 1. 人工智能辅助斯格明子晶格的定量解析。（a）机器视觉识别共形斯格明子晶格的局域配位、缺陷与共形弧。（b）图表示、等变图神经网络与无监督聚类实现节点级相态识别及相分数追踪。 本文得到国家自然科学基金、国家重点研发计划及国家科技重大专项项目资助。