陕西师範大學 SHAANXI NORMAL UNIVERSITY

化学化工学院 School of Chemistry & Chemical Engineering

新概念传感器与分子材料研究院 INSTITUTE OF NEW CONCEPT SENSORS AND MOLECULAR MATERIALS

新概念传感器与分子材料研究院 简报 01 2024

Institute of New Concept Sensors and Molecular Materials Newsletter

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房喻院士研究组举办 2024 新年联欢会
Fang Graduate Group 2024 New Year party held

一月大事记 Events in January

一元复始，万象更新。时序轮替，辞旧迎新。伴随着冬日温暖的阳光，2024 年元旦如约而至。2024 年 1 月 1 日下午，房喻院士研究组在新概念传感器与分子材料研究院报告厅举办了师生新年联欢会。

联欢会由一年级博士生李晶和邵洋涛主持，房喻院士和研究生同学们满怀着喜悦的心情，带着对新的一年的美好期盼欢聚一堂。

联欢会有才艺表演、互动游戏、抽奖环节和颁奖仪式。同学们合唱了《天下》《歌曲串烧》，表演了精彩有趣的魔术。之后进行了紧张刺激的乒乓接力、抢板凳、猜成语和萝卜蹲等游戏，感受合作与挑战的乐趣，还进行了激动人心的抽奖。在最后的颁奖环节，每位同学都获得了属于自己

的专属奖状。

最后，房喻院士作了总结并致新年寄语，祝愿大家在新的一年越来越好。

Everything is renewed when we ring out the old year and ring in the new. With the warm sunshine of winter, the New Year's Day of 2024 arrives as promised. On January 1, 2024, Prof. Fang Yu's Graduate Research Group held a Teacher-Student New Year party in the lecture hall of the Institute of New Concept Sensors and Molecular Materials.

The party was anchored by first-year doctoral students Li Jing and Shao Yangtao. Prof. Fang Yu and Fang Group graduate students gathered together in a joyful mood and with good expectations for the New Year.

There were talent shows, interactive games, lucky draw and award ceremony during the party. The students sang "Under Heaven" and a combination of songs, and performed magic tricks. After the tense and exciting ping-pong relay, stool snatching, idiom guess guessing and carrot squatting and other games, everyone felt the fun of cooperation and challenge, and carried out the exciting lucky draw. In the final awarding session, each student received his or her own certificate of merit.

Finally, Prof. Fang Yu made a conclusion and sent a New Year message, wishing everyone a better year of 2024.

房喻院士出席“仿生超浸润界面材料与界面化学”年度学术交流会

Fang Yu attends annual academic conference of “Biomimetic Super-infiltrated Interface Materials and Interface Chemistry”

2024 年 1 月 5 日，房喻院士应邀赴北京出席中国科学院理化技术研究所主办的“仿生超浸润界面材料与界面化学”年度学术交流会。

“仿生超浸润界面材料与界面化学”是由江雷院士主持、中国科学院理化技术研究所牵头承担的基础科学中心项目。

On January 5, 2024, Prof. Fang Yu attended the annual academic exchange conference of “Biomimetic Super-infiltrated Interfacial Materials and Interfacial Chemistry” hosted by the Technical Institute of Physics and Chemistry of the Chinese Academy of Sciences in Beijing.

“Biomimetic Super-infiltrated Interfacial Materials and Interfacial Chemistry” is a Basic Science Center project chaired by CAS academician Jiang Lei and undertaken by TIPC-CAS.

房喻院士出席“软物质界面化学和生物界面化学”学科研讨会

Fang Yu attends symposium on Soft Matter Interfacial Chemistry and Biological Interfacial Chemistry

2024 年 1 月 6 日，房喻院士应邀赴北京出席中国科学院化学科学部主办的“软物质界面化学和生物界面化学”学科研讨会。

On January 6, 2024, Prof. Fang Yu attended the symposium on Soft Matter Interfacial Chemistry and Biological Interfacial Chemistry hosted by the Department of Chemical Sciences, Chinese Academy of Sciences in Beijing.

房喻院士出席仿生材料战略研讨会

Fang Yu attends strategic seminar on biomimetic materials

2024 年 1 月 11 日，房喻院士应邀赴苏州工业园区出席由苏州实验室主办的仿生材料战略研讨会，为我国加强仿生材料领域布局建言献策。

On January 11, 2024, Prof. Fang Yu attended the strategic seminar on biomimetic materials hosted by Suzhou Laboratory in Suzhou Industrial Park, and participated in discussions and offered suggestions for strengthening the layout of biomimetic materials in China.

西安电视台“西安新闻”播出介绍研究院专题片

Special program featuring INCSMM broadcast in Xi’an TV Station “Xi’an News”

2024 年 1 月 13 日，西安电视台“西安新闻”栏目以《发挥化学学科新物质创制优势 实现从跟跑到领跑转变》为题，播出了采访新概念传感器与分子材料研究院，介绍研究院科研情况的专题片。

专题片在“勇当先行示范 打造创新名城”专栏播出，采访了刘太宏副教授、彭军霞教授和房喻院士，全面介绍了研究院在薄膜荧光传感器和分子凝胶材料两个研究方向上的发展历程、特色研究、研究进展及成果转化情况。

房喻院士在专题片中说：“我相信我们的市委、市政府也是希望高校能够把我们的科研工作能够更好地跟地方的经济社会发展结合起来，通过我们的科学研究来使得地方的经济社会发展地更好。”

“西安新闻”视频链接：https://yuandian.xiancity.cn/application/fcinformation/mobile/#/ArticleDetail/300992/undefined

On January 13, 2024, the “Xi’an News” column of Xi’an TV Station broadcast a special program featuring the Institute of New Concept Sensors and Molecular Materials and introducing the research achievements of the Institute under the title of “Taking advantage of the creation of new substances in Chemistry, Realize the transformation from following to leading”.

Broadcast in the “Brave to be a vanguard, Build an innovative city” series, the feature program interviewed Assoc. Prof. Liu Taihong, Prof. Peng Junxia and Prof. Fang Yu, and comprehensively introduced the development history, characteristics, research progress and achievements transformation of the Institute in the two research directions of film-based fluorescence sensors and molecular gel materials.

In the interview, Prof. Fang Yu said: “I believe that Xi’an municipal Party committee and government also hope that universities can better integrate our scientific research work with the local economic and social development, and through our scientific research to make the local economic and social development better.”

“Xi’an News” Link:w https://yuandian.xiancity.cn/application/fcinformation/mobile/#/ArticleDetail/300992/undefined

房喻院士出席陕西省首届基础教育教学指导委员会会议并作报告

Fang Yu speaks at meeting of first Shaanxi Province Basic Education Teaching Steering Committee

2024 年 1 月 19 日，陕西省首届基础教育教学指导委员会第二次全体委员会议召开，房喻院士出席会议并作题为“构建新发展格局背景下教育与基础研究的作用”的专题报告，解读了当前教育和基础研究服务新发展格局的举措，为做好基础教育工作提供新思路。

On January 19, 2024, Prof. Fang Yu attended the second plenary meeting of the first Basic Education Teaching Steering Committee of Shaanxi Province and gave a report titled “The Role of Education and Basic Research in the Context of Building a New Development Model”, explaining the current measures of education and basic research in service of the new development model, and providing new ideas for better work in basic education.

研究院举行第一届“致新杯”科技创新大赛初赛选拔赛和导师见面会

First “Zhixin Cup” Sci-tech Innovation Competition preliminary selection and coach meeting held

2024 年 1 月 6 日，新概念传感器与分子材料研究院在报告厅举行了陕西师范大学第一届“致新杯”科技创新大赛初赛选拔赛。围绕超交联聚合物材料的制备及其应用、绿色阻燃固液复合材料、BTEX 传感器的研制三个方向，在 29 支报名参赛队伍基础上遴选出涵盖数学、物理、生命科学、化学、材料、计算机等专业的参赛学生 37 人，组成了 8 支参赛队伍。

1 月 22 日，研究院举行了相关指导教师、工程技术人员与参赛学生代表的导师见面会，针对课题要求、任务划分、团队分组等事项进行了沟通交流。房喻院士出席见面会，并就赛事相关事宜提出了要求和希望。

此次大赛旨在发挥学校学科和研究院平台资源优势，按照“突出源头创新、培育创新文化、探索颠覆性技术”的原则，培养学生探究科学问题和主动发现、自主研究、自主创新的科学精神，激发广大学生的创新潜能和创造活力。

On January 6, 2024, the Institute of New Concept Sensors and Molecular Materials held the preliminary selection of the first Shaanxi Normal University “Zhixin Cup” Science and Technology Innovation Competition in its lecture hall. Focusing on the three directions of preparation and application of hypercrosslinked polymer materials, green antiflaming solid-liquid composite materials, and development of BTEX sensors, 37 participating students from mathematics, physics, life science, chemistry, materials, computer and other majors were selected on the basis of 29 participating teams, and re-grouped into eight teams.

On January 22, the Institute held a meeting between the coaches, engineering and technical personnel and the representatives of the participating students, and they communicated on the project requirements, task division, member grouping and other issues.

Prof. Fang Yu attended the meeting and put forward requirements and hopes.

The competition aims to give full play to the advantages of the university's disciplines and platform resources of the institute, and in accordance with the principle of "highlighting original innovation, cultivating innovation culture, exploring disruptive technologies", cultivate students' spirit of exploring scientific problems and active discovery, independent research and innovation, and stimulate their innovative potential and creative vitality.

校领导看望慰问房喻院士

SNNU leaders pay new year visit to Prof. Fang Yu

2024 年 1 月 25 日，校党委书记李忠军、党委副书记卢胜利等来到新概念传感器与分子材料研究看望慰问房喻院士。

李忠军、卢胜利代表学校向房喻院士致以节日问候和新春祝福，感谢他为学校作出的贡献和对学校各项工作的关心支持，并听取房喻院士对学校事业发展的意见建议。

校党委校长办公室主任袁一芳、副主任罗卫涛、行政科科长李琛陪同慰问。

On January 25, 2024, Li Zhongjun and Lu Shengli, secretary and deputy secretary of the Party Committee of the Shaanxi Normal University, came to visit Prof. Fang Yu at the Institute of New concept Sensors and Molecular Materials.

Li Zhongjun and Lu Shengli, on behalf of the university, extended holiday greetings and New Year wishes to Fang Yu, thanked him for his contribution to the university and his support for the work of the university, and listened to Fang Yu's opinions and suggestions on the development of the university.

SNNU Administrative Office director Yuan Yifang, deputy director Luo Weitao, Administrative Section chief Li Chen accompanied the visit.

多家单位机构到访研究院看望慰问房喻院士

Visitors from multiple units and institutions pay new year visit to Prof. Fang Yu

2024 年 1 月，岁末年初，龙年新年即将到来之际，多家友好合作单位的负责人陆续前来新概念传感器与分子材料研究院看望慰问房喻院士，并与房喻院士及副院长丁立平教授、办公室主任杨小刚、刘太宏副教授、刘小燕副教授等座谈交流。

其中，1 月 24 日，西安医学院副校长巩守平等一行来访；1 月 25 日，国家毒品实验室陕西分中心主任姚震一行 3 人到访；1 月 26 日，西咸新区科技创新和新经济局局长王斌等一行 5 人到访；1 月 26 日，陕西师范大学材料科学与工程学院党委书记郑鹏、院长曾京辉等 7 人到访；1 月 26 日，沣东新城统筹科技管办主任杜磊等一行 4 人到访； 1 月 27 日，中国化学会邓春梅、冯娟到访。

In January 2024, when it approaches the beginning of the Year of the Dragon, the heads of several friendly cooperation units and institutions paid New Year visit to Prof. Fang Yu at the Institute of New Concept Sensors and Molecular Materials, and talked with him and vice dean Prof. Ding Liping, Administrative Office director Yang Xiaogang and Assoc. Prof. Liu Taihong and Assoc. Prof.Liu Xiaoyan.

Among them were Xi'an Medical University vice president Gong Shouping on January 24, National Anti-Drug Laboratory Shaanxi Regional Center director Yao Zhen on January 25, Xixian New District Science and Technology Innovation and New Economy Bureau director Wang Bin on January 26, Shaanxi Normal University's School of Materials Science and Engineering Party Secretary Zheng Peng and dean Zeng Jinghui on January 26, Fengdong New City Science and Technology Management Office director Du Lei on January 26, and Chinese Chemical Society's Deng Chunmei and Feng Juan on January 27.

研究院举行 2023 年度总结表彰会

INCSMM 2023 Summary and Commendation Meeting held

2024 年 1 月 31 日下午，新概念传感器与分子材料研究院在报告厅举行 2023 年度年终总结表彰会，研究院科研团队教师、专职科研人员、行政人员及博士后约 40 人参加表彰会，会议由副院长丁立平教授主持。

首先，行政人员 3 人、专职科研人员 5 人、科研团队教师 15 人分别作 2023 年度工作汇报。接着，丁立平副院长宣读了 2023 年度获奖人员名单，王佩、何怡楠获“科研成果转化突出贡献奖”，彭军霞获“人才培养突出贡献奖”，刘凯强、刘小燕获“标志性论文奖”，马佳妮获“国家级人才项目突破奖”。房喻院士为获奖老师颁发荣誉证书并与获奖者合影留念。

最后，房喻院士发表总结讲话，鼓励大家在研究院平台上一起努力做出更大成绩，并祝大家新年快乐。

On January 31, 2024, the Institute of New Concept Sensors and Molecular Materials held the 2023 Summary and Commendation Meeting in the lecture hall. About 40 research faculty members, full-time research assistants, administrative staff members and postdoc researchers of the Institute attended the meeting, which was chaired by vice dean Prof. Ding Liping.

First of all, three administrative staff members, five research assistants, and fifteen research faculty members presented their 2023 work reports respectively.

Then, Prof. Ding Liping read out the list of 2023 awardees, who are Wang Pei and He Yinan for the “Outstanding Contribution Award for Research Achievements Transformation”, Peng Junxia for the “Outstanding Contribution Award for Talent Cultivation”, Liu Kaiqiang and Liu Xiaoyan for the “Representative Research Paper Award”, and Ma Jiani for the “National Talent Project Breakthrough Award”. Prof. Fang Yu presented certificates of honor to the commended award winners and took photos with them.

In his concluding speech, Prof. Fang Yu encouraged everyone to work together to make greater achievements on the Institute platform, and wish them a happy New Year of Dragon.


过去的一年，是忙碌充实的一
各位老师的支持与帮助下，我认真
进中完成，在工作过程中我学到了
院的定位和发展，使我视野更加开
一年来主要的工作情况、获得感受


对标目标定位
促进成果产出
研究院建设
基本原则
利于人才培养


2023年度工作
汇报人：罗艳彦 时间：2024.1.31


2023年终工
厚德 积学
励志 敦行


2023年
年终总结汇报
汇报人：文瑞娟
日 期：2024-01-31

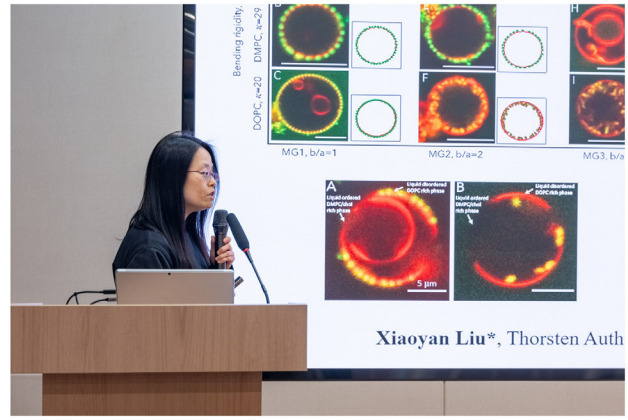

半自动化生产线搭建及运行
半自动生产线各设备调研、采购、运行；
研究院实验室规模小试生产；
化工原料采购、半自动化生产、机加工
质检、包装、收发货年度工艺线试运行。
缓释材料生产汇总
半自动化生产线各工艺文件的确立；
实验室规模小试生产情况汇总（毛坯棒
材数量、合格加工膜片数量、年度支出
与收益情况、工艺环节不足）；
全年产品缺陷与生产不足的问题分析、
总结及解决措施。
应用市场拓展
缓释领域：高效杀毒剂二氧化氯缓释（已推
广），香氛、药物精油（资料调研及效果初
试）活性成分缓释；
防水透气领域：电子设备防护材料（跟进）；
国内外对标产品市场调研。

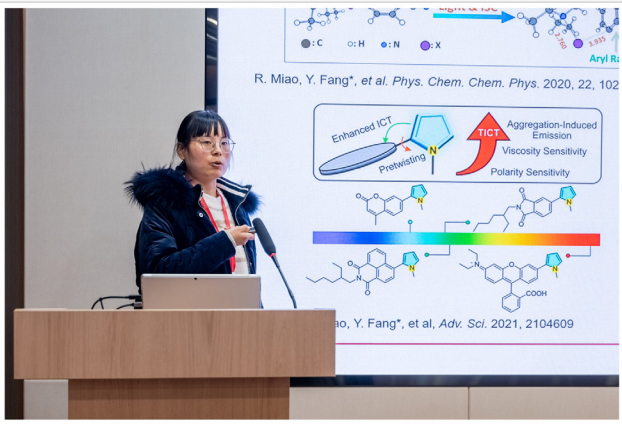

2023年
述职报告


2023年年终复盘


2023年度工作汇报
2023 Annul Report
Institute of New Concept Sensors and Molecular Materials
School of Chemistry and Chemical Engineering
Shaanxi Normal University
汇报人：薄鑫
2024年1月31日星期三


招生宣讲（桥山中学、澄城中学、


Xiaoyan Liu*, Thorsten Auth


R. Miao, Y. Fang*, et al. Phys. Chem. Chem. Phys. 2020, 22, 102
Enhanced ICT
Pretwisting
TICT
Aggregation-Induced Emission
Viscosity Sensitivity
Polarity Sensitivity
Y. Fang*, et al, Adv. Sci. 2021, 2104609


2023年度汇报
汇报人：薛东旭
陕西师范大学化学化工学院
2024年01月31日

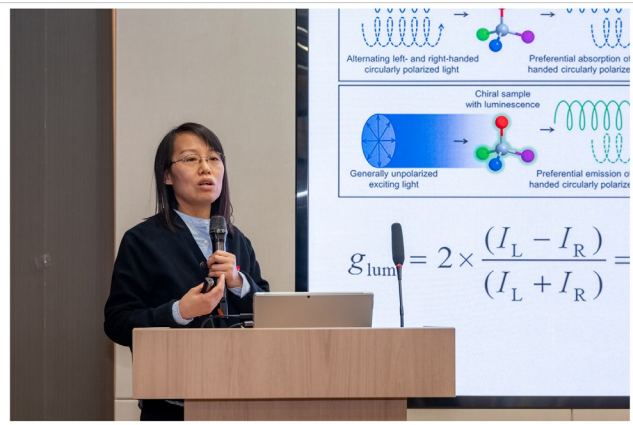

2023年工作总结
马佳妮


2023年度工作汇报
彭浩南
陕西师范大学化学化工学院


工作汇报 | 计划、总结
强信心、多合作，参与合作型科研
凝特色、多看路，推进高质量发展
汇报人：刘太宏
liuth121@snnu.edu.cn


1. 作为第一指导教师，指导学生参加第九届“互联网+”创新创业大赛/陕西赛区金奖/国家铜奖。
获奖证书
优秀创新创业导师


2023年度汇报
汇报人：刘凯强
kaiqiangliu@snnu.edu.cn


Alternating left- and right-handed circularly polarized light
Chiral sample with luminescence
Generally unpolarized exciting light
$g_{lum} = 2 \times \frac{(I_L - I_R)}{(I_L + I_R)} =$


新概念传感器与分子材料研究院
第二项


新概念传感器与分子材料研究院
第二项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第二项

Recent Advances in Construction Strategies for Fluorescence Sensing Films

Haonan Peng, Liping Ding*, and Yu Fang*

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Publication Date: January 18, 2024
https://doi.org/10.1021/acs.jpclett.3c03130

综述 荧光传感薄膜构建策略最新进展

近日，陕西师范大学房喻院士团队在 JPC Letters 上发表了荧光传感薄膜构建策略最新进展的综述文章，彭浩南教授为第一作者，房喻教授和丁立平教授为通讯作者。

[背景介绍]

薄膜基荧光传感器（FFSs）因其具有高灵敏度、高特异性、免受光散射干扰以及非侵入性等优势，在隐藏性爆炸物 / 非法药物检测、溶解氧及挥发性有机化合物测定等方面得到了广泛应用，并入选“2022 年度国际纯粹与应用化学联合会（IUPAC）十大新兴化学技术”。

薄膜基荧光传感涉及复杂的表界面相互作用，概括而言主要包含两个基本过程：“传能”和“传质”。其中，“传能”过程是指传感单元与分析物分子间发生相互作用，从而影响传感单元发光过程中的能量变化，使其荧光强度、寿命、发射波长等发生改变；“传质”过程是指分析物分子在荧光活性层所发生的吸附、扩散和解吸过程。由此可见，薄膜传感性能主要取决于决定传感发生机制的传感单元，以及影响分析物分子吸附、解析和扩散的活性层结构。

[综述概要]

本综述重点介绍了荧光传感薄膜构建策略的最新进展。首先，总结了为提高荧光单元与分析物间“传能”作用效率的传感分子设计策略，包括开发具有分子内电荷转移（ICT）特性的分子、显示有多重发射特性的分子，以及具有激发波长依赖发射行为的单分子，这些策略特别适用于追踪那些光电惰性或缺乏特定识别基团的分析物；接着概述了在构建活性层方面的最新进展，特别是通过构建分子通道来提高传感过程中的“传质”效率，包括开发非平面结构分子、共轭微孔聚合物、框架结构材料和多孔纳米薄膜等先进材料，这些材料有助于形成具有丰富多孔结构的活性层。

除了上述构建策略之外，科学家

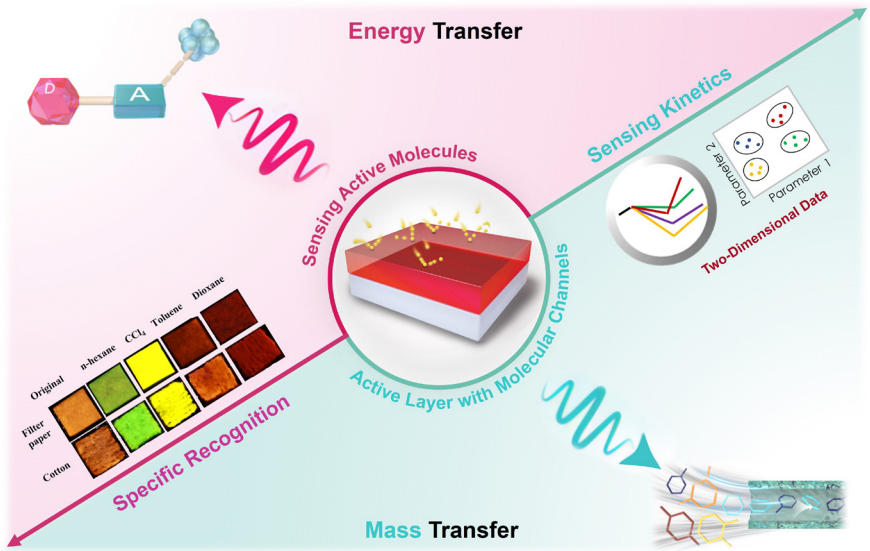

图 1. 薄膜荧光传感基本过程
Figure 1. Scheme of the basic process of film-based fluorescence sensing

将模拟仿真与微纳加工技术相结合，用于优化传感薄膜活性层和基底的表面形态及微观结构，为在微米和纳米尺度上的高精度结构设计提供了物理手段。该方法有望成为一种提升薄膜基荧光传感器性能的高效方法。

[挑战和机遇]

尽管在薄膜基荧光传感器的构建和应用方面取得了显著进展，但在这一领域仍面临一系列挑战和机遇。首先，对于薄膜传感中涉及的传能和传质机制需要更深入的理解。现有的扩散模型，如克努森扩散和分子扩散理论，主要关注分析物分子的物理特性，如气体常数和分子量，而忽视了分子的化学属性。实际上，分析物与荧光活性层之间的分子相互作用在影响传质过程中扮演着关键角色。因此，需要进一步的研究来阐明基于薄膜荧光传感器中分子相互作用的复杂相互关系。其次，迫切需要进行全面的调查研究，以深入了解新型传感薄膜的发展，这涉及新型传感分子的合成和具有分子通道物理化学结构明确的活性层的构建。在这些领域的深入研究将促进先进传感薄膜的设计和制造，提高其性能。最后，设计和集成稳健的环境传感器是一个重要挑战。实际样品中组分庞杂，待分析物可能会受到其他化合物的干扰，从而影响传感过程的准确性和选择性。因此，需要更加关注开发具有高选择性的网格化环境传感器。

相关论文发表在 JPC Letters 上，陕西师范大学彭浩南教授为文章的第一作者，丁立平教授和房喻教授为通

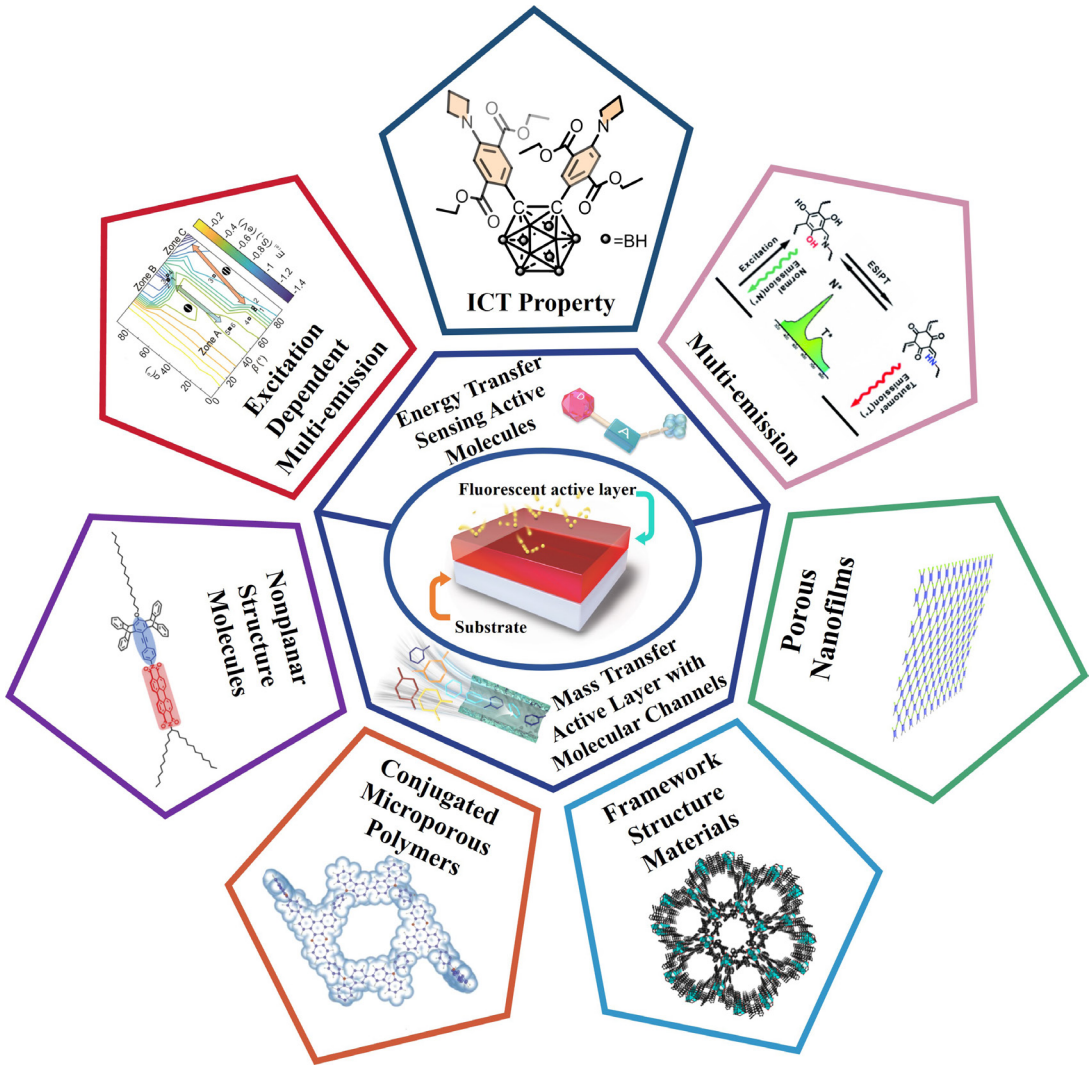

图 2. 荧光传感薄膜构建策略进展。

Figure 2. Proposed photocatalytic reduction reaction mechanism for the HCOOH and CO formation.

讯作者。

通讯作者：房喻教授、丁立平教授，陕西师范大学
第一作者：彭浩南教授，陕西师范大学
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Recently, Prof. Yu Fang's research group published a review on the latest advancements in fluorescent sensing film construction strategies in JPC Letters. Prof. Peng Haonan is the first author, and Prof. Fang Yu and Prof. Ding Liping are the correspondence authors.

Background

A year ago, film-based fluorescent sensors (FFSs) were recognized in the "IUPAC Top Ten Emerging Technologies in Chemistry 2022" due to their extensive application in detecting hidden explosives, illicit drugs, and volatile organic compounds.

The active sensing layer primarily consists of fluorescent compounds, supported by a solid substrate. Film-based fluorescence sensing entails intricate interfacial interactions, which can generally be categorized into two fundamental processes: "energy transfer" and "mass transfer" (Fig 1). Among these, the "energy transfer" process pertains to the interactions between the sensing unit and the analyte molecule. These interactions impact the energy transformation within the luminescence process of the sensing unit, leading to alterations in fluorescence intensity, lifetime, and emission wavelength. While the "mass transfer" involves the adsorption, diffusion, and desorption of analyte molecules within the active layer. The efficacy of the sensing film is primarily reliant on the sensing mechanism and the structural composition of the sensing unit within the active layer.

Overview

Recently, Prof. Yu Fang published a review on the latest advancements in fluorescent sensing film construction strategies in JPC Letters. This review focuses on the latest developments in the construction strategies of fluorescent sensing films. Firstly, we summarize innovative design strategies for obtaining sensing active molecules that enhance "energy transfer" between fluorophores and analyte molecules. We have a distinct emphasis on a range of methodologies, encompassing the acquisition of molecules exhibiting intramolecular charge transfer (ICT) characteristics, solitary molecules demonstrating multiple emission profiles, and single molecules displaying excitation-dependent multi-emission behaviors. These strategies facilitate the tracking of analytes devoid of photoelectric reactivity or reliant on specific recognition moieties. Secondly, we outline the latest developments in constructing active layers with molecular channels to enhance "mass transfer" during the sensing process. Advanced materials such as nonplanar-structured molecules, conjugated microporous polymers, framework-structured materials, and porous nanofilms are employed to fabricate active layers with porous structures.

In addition to the aforementioned fabrication strategies, the recent integration of finite element simulation and microfabrication technologies has emerged as a systematic approach to modulate the surface morphology and microstructure of the substrate in sensing films. These techniques provide the physical means to implement these designs with high precision structured at the micro and nanoscale. 85-87 This may become a highly effective method to enhance the performance of film-based fluorescent sensors.

Challenges and Opportunities

While significant progress has been achieved in the construction and application of FFSs, several challenges and opportunities remain to be addressed in this field. Firstly, there is a need for a deeper understanding of the exact mass transfer mechanisms involved in film sensing. Prevailing diffusion models, such as Knudsen diffusion and molecular diffusion theories, focus mainly on the physical characteristics of analyte molecules, such as gas constant and molecular weight, while overlooking the chemical properties of the molecules. In reality, the molecular interactions between analytes and the fluorescent active layer play a crucial role in influencing the mass transport process. Therefore, further research is required to elucidate the intricate interplay between molecular interactions in film-based fluorescent sensors. Secondly, comprehensive investigations are urgently needed to gain profound insights into the development of superior sensing films. This entails the synthesis of novel sensing molecules and the construction of active layers with well-defined molecular channels. These aspects form the foundation for the preparation and application of FFSs. In-depth studies in these areas will enable the design and fabrication of advanced sensing films with enhanced performance and sensitivity. Lastly, the design and integration of robust environmental sensors pose a major challenge. Real samples containing target analytes in complex mixtures can be prone to interference from other compounds, thereby affecting the accuracy and selectivity of the sensing process. Consequently, the development of grid environmental sensors with high selectivity is an emerging approach that requires dedicated efforts and attention.

The relevant paper was published in JPC Letters, with Professor Haonan Peng as the first author, and Professors Liping Ding and Yu Fang as the corresponding authors.

Article Information

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Correspondence Authors: Prof. Fang Yu, Prof. Ding Liping, Shaanxi Normal University
First Author: Prof. Peng Haonan, Shaanxi Normal University
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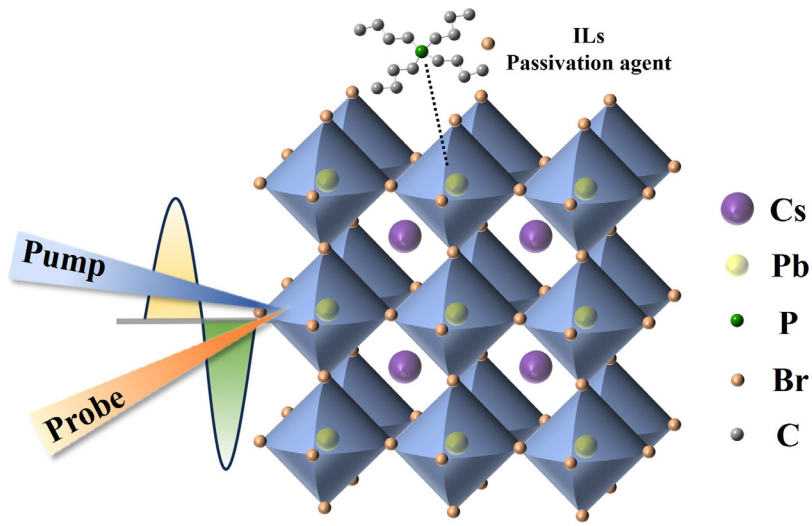
Article

Revealing Mechanisms and Ultrafast Dynamics of Tetrabutyl Phosphonium Bromide Ionic Liquids Post-Treatment in $CsPbBr_3$ Perovskite Films

Weiting Zhang, Jiancong Zheng, Wei Huang, Min Zhao, Bingyu Jiang, Hongtao Bian,* and Yu Fang

四丁基溴化鏻离子液体后处理 $CsPbBr_3$ 薄膜的机理及超快动力学研究



新型钙钛矿太阳能电池凭借低成本、高效率、低能耗等特点，在光电器件领域受到了广泛的关注。而其固有的缺陷会影响光生载流子的复合、稳定性并妨碍光电转换，因此薄膜缺陷钝化是提高稳定性的有效方式。选用新型离子液体钝化剂钝化 $CsPbBr_3$ 薄膜，可以在一定程度上减少缺陷的形成和抑制非辐射复合。

采用基础表征结合超快飞秒瞬态吸收的技术，对钙钛矿薄膜中的载流子冷却和复合过程进行了全面研究。期望能进一步分析离子液体对薄膜缺陷钝化的效果，探究其光激发后钙钛矿材料中载流子产生和弛豫的钝化机制和光物理现象。

本工作中，我们选用 $[P_{4444}]Br$ 作为钝化剂来说明离子液体与 $CsPbBr_3$ 薄膜之间相互作用的机理。采用基本表征技术和超快 fs–TA 光谱相结合的方法，对光激发后钙钛矿薄膜中载流子产成和弛豫的光物理过程进行了深入的探究。我们发现 $[P_{4444}]Br$ 钝化后利于薄膜结晶，荧光强度增加，薄膜缺陷被明显抑制。疏水性烷基侧链的四丁基鏻阳离子和大小匹配的素阴离子一致，共同表现出明显的钝化效果。与对照样品相比，钝化后薄膜的寿命可以用三指数函数进行拟合，这可以与薄膜中带隙激发后的复合动力学联系起来。衰减过程分别归属于带内热激子弛豫（τ_1）、非辐射复合（τ_2）和带边激子辐射复合（τ_3）过程。其中辐射

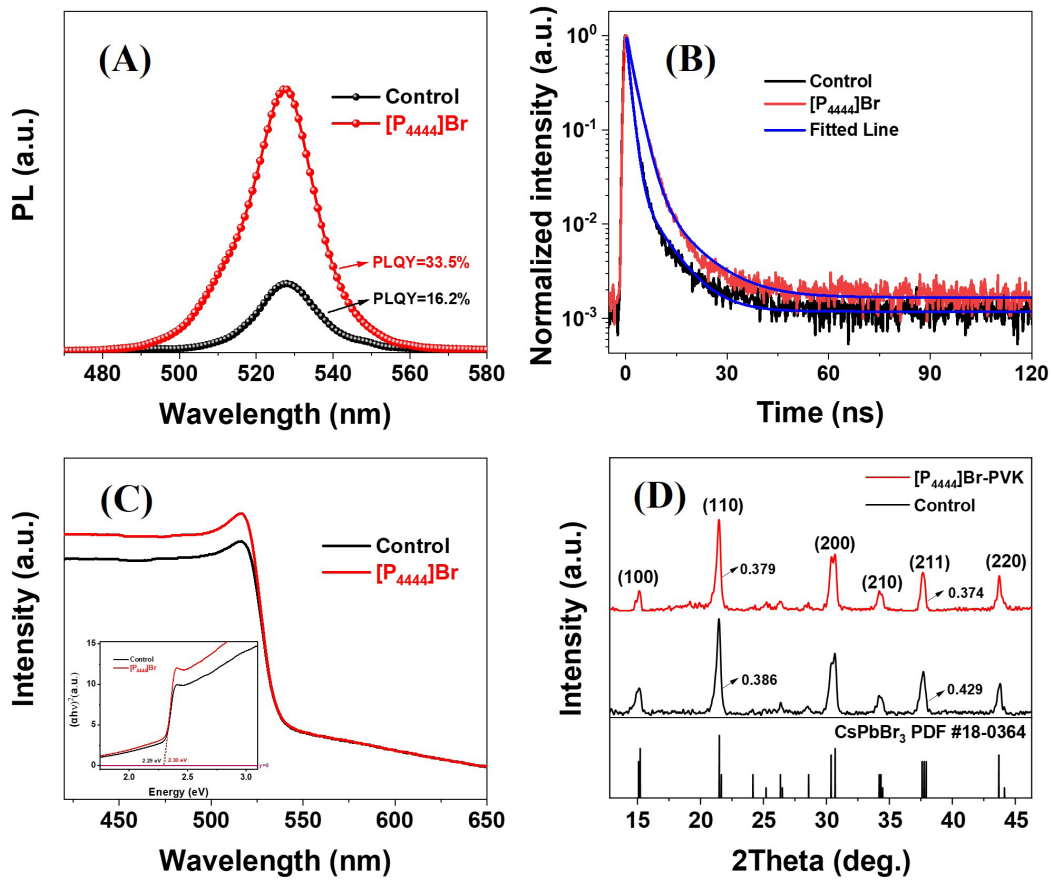


图 1. 离子液体 [P_{4444}]Br 钝化 $CsPbBr_3$ 薄膜前后的基础表征 (A) 薄膜的稳态荧光光谱，(B) 时间分辨荧光光谱，(C) 紫外 - 可见吸收光谱，(D)XRD 图谱。选用 PDF 标准卡片对比，对两个典型特征峰的半高宽进行了相应标注。

Figure 1. (A) Steady-state PL spectra, (B) time-resolved PL measurements,(C) UV−vis absorption spectra, and (D) XRD pattern of $CsPbBr_3$ films and with the presence of [P_{4444}]Br treatment. The fwhm of two typical peaks was labeled accordingly..

复合的时间常数增加了约 2 倍。这种效应通过有效消除钙钛矿薄膜中的表面缺陷，同时抑制陷阱辅助的非辐射复合，显著提高了薄膜的整体质量。

第一作者：陕西师范大学硕士研究生张伟婷
通讯作者：陕西师范大学边红涛教授
全文链接：https://pubs.acs.org/doi/10.1021/acs.jpcc.3c06371

New perovskite solar cells (PSCs) have garnered significant attention due to their low cost, high efficiency and low energy consumption in the realm of optoelectronic devices. The inherent defects will impact the recombination of photogenerated carriers, stability and hamper photoelectric conversion. One effective approach to improving stability involves the procedure of defect passivation for perovskite films. Consequently, tetrabutyl phosphine bromide ionic liquids (ILs) were chosen as passivating agents for $CsPbBr_3$ perovskite films and it can reduce the formation of defects and inhibit non-radiative recombination to a certain extent.

A range of basic characterization techniques and ultrafast femtosecond transient absorption (fs-TA) spectroscopy, were employed to comprehensively investigate the carrier cooling and recombination processes in the perovskite films. It is expected to further analyze the effect of ionic liquids on the passivation of film defects, and to explore the passivation mechanism and the photophysical phenomena related to carrier generation and relaxation in perovskite materials following photoexcitation.

In this work, the investigation utilized [P_{4444}]Br ILs as a passivating agent to elucidate the mechanistic interactions between ILs and

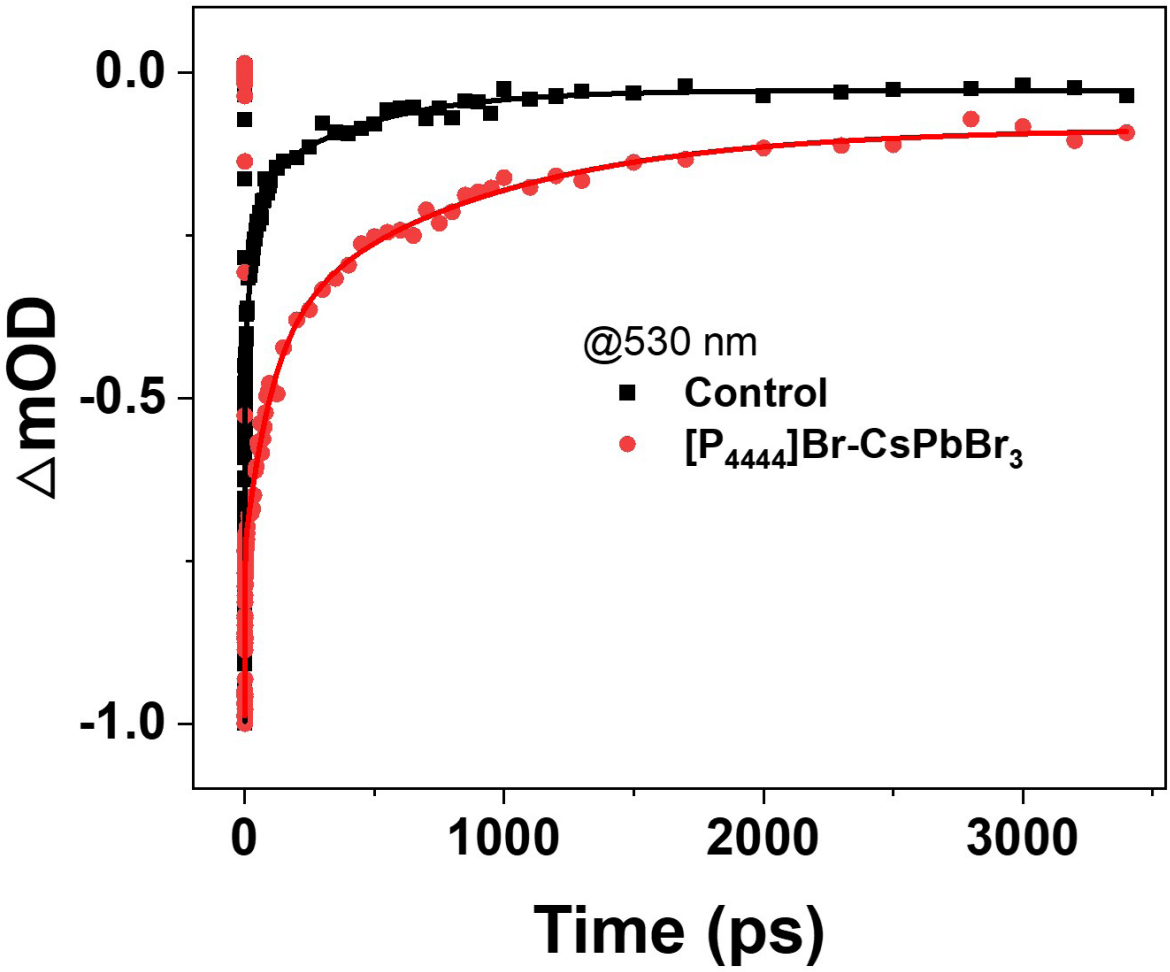


图 2. 钝化前后 $CsPbBr_3$ 薄膜的基态漂白 (GSB) 信号的归一化 TA 动力学。

Figure 2. Normalized TA kinetics of the ground state bleaching (GSB) signal for the control and modified $CsPbBr_3$ films.

CsPbBr3 films. By combining basic characterization techniques and ultrafast fs-TA spectroscopy, the photophysical processes of carrier generation and relaxation in perovskite films after photoexcitation were deeply explored. It is beneficial to the crystallization of the film, and the fluorescence intensity increases after $[P_{4444}]Br$ passivated the surface. Our findings indicate that the film defects are significantly suppressed. The tetrabutyl phosphine cation of the hydrophobic alkyl side chain is consistent with the size-matched halogen anion, which shows a pronounced passivation effect. Compared with the control film, the lifetime of the passivated film can be fitted by a triexponential function. The measured lifetime can be linked to the recombination dynamics following band gap excitation in the film. The decay processes are attributed to in-band thermal exciton relaxation (τ_1), non-radiative recombination (τ_2), and band-edge exciton radiative recombination (τ_3) processes, respectively. The time constant for the radiative recombination process increased by a factor of approximately 2 in the passivation sample compared with the control sample. This effect significantly elevates the overall film quality by effectively eliminating surface defects in the perovskite film and inhibiting trap-assisted nonradiative recombination.

First Author: Zhang Weiting, Master's degree candidate, Shaanxi Normal University
Correspondence Author: Prof. Bian Hongtao, Shaanxi Normal University
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内蒙古大学雷海瑞研究员应邀作学术报告

Lei Hairui of Inner Mongolia University invited to give a report

2024 年 1 月 3 日，光子鼻与分子材料团队邀请内蒙古大学雷海瑞研究员在新概念传感器与分子材料研究院报告厅作了题为“从‘人造原子’到‘人造分子’”的学术报告。报告由刘静教授主持，研究院部分教师和研究生参加了报告会。

雷海瑞研究员首先介绍了“人造原子”的概念及前沿动态，从量子点晶面结构、表界面及光学性质等维度阐述了“人造分子”制备过程中的关键要素。随后介绍了其团队利用“表面重构”策略精准控制量子点的晶面结构和发光性质、实现由“人造原子”定向拼接形成“人造分子”等工作。

报告结束后，雷海瑞研究员与在场师生就相关问题进行了讨论，并与团队老师合影留念。

雷海瑞老师 2017 年毕业于陕西师范大学并获得理学博士学位，导师为刘静教授，现为内蒙古大学研究员、博士生导师。

On January 3, 2024, the Photonic Nose and Molecular Materials Group invited Lei Hairui, a researcher from Inner Mongolia University, to give a report titled “From Artificial Atoms to Artificial Molecules” in the lecture hall of the Institute of New Concept Sensors and Molecular Materials. The report was chaired by Prof. Liu Jing and attended by some faculty members and graduate students.

Lei Hairui first introduced the concept and frontier research background of artificial atoms, and expounded the key elements in the preparation process of artificial molecules from the dimensions of crystal surface structure, surface interface and optical properties of quantum dots. Then he introduced the work of his team using the surface reconstruction strategy to accurately control the crystal surface structure and luminous properties of quantum dots, and realize the directional splicing of artificial atoms to form artificial molecules.

After the report, Lei Hairui discussed relevant issues with the teachers and students present, and took a photo with the teachers.

Lei Hairui graduated from Shaanxi Normal University in 2017 with a Doctor of Science degree under the supervision of Prof. Liu Jing, and is currently a researcher and doctoral supervisor of Inner Mongolia University.

马佳妮教授赴凯立新材料公司参观座谈并作报告

Ma Jiani visits and presents at Kaili Catalyst and New Materials Company

2024 年 1 月 12 日，新概念传感器与分子材料研究院马佳妮教授应西安凯立新材料股份有限公司副总工程师高武博士邀请，前往凯立新材料参观、座谈，并作题为“激发态分子反应机制研究及分子设计思路”的报告。

西安凯立新材料股份有限公司是西北有色金属研究院控股的科创板上市企业，主要从事催化材料、催化技术、废旧催化剂回收再加工循环利用的研究、开发和生产。

On January 12, 2024, invited by deputy chief engineer Dr. Gao Wu of Kaili Catalyst and New Materials Co., Ltd., Prof. Ma Jiani of the Institute of New Concept Sensors and Molecular Materials visited Kaili and gave a report titled “Research on Mechanism of Excited State Molecular Reaction and Molecular Design Ideas”.

Kaili Catalyst and New Materials is a listed enterprise of the Science and Technology Innovation Board held by the Northwest Institute of Non-Ferrous Metals, mainly engaging in the research, development and production of catalytic materials, catalytic technology, and recycling and reuse of waste catalysts.

陕西三秦环保科技股份有限公司来访

Shaanxi Sanqin Environmental Protection Technology visitors received

2023 年 1 月 13 日，陕西三秦环保科技股份有限公司党委书记、董事长周恩泉，党委副书记、总经理田延生一行来访，在丁立平副院长陪同下参观了新概念传感器与分子材料研究院，并与房喻院士进行了会谈交流。

陕西三秦环保科技公司副总经理常伟娟、技术中心业务主管左武军和综合部助理侯方，新概念传感器与分子材料研究院办公室主任杨小刚和专职科研人员王佩参加了会谈交流。

On January 13, 2023, Shaanxi Sanqin Environmental Protection Technology Co., Ltd guests, headed by Party secretary and chairman Zhou Enquan and deputy Party secretary and general manager Tian Yansheng, visited the Institute of New Concept Sensor and Molecular Materials.

INCSMM vice dean Prof. Ding Liping accompanied the guests in a tour of the institute, before they met and had talks with Prof. Fang Yu.

Shaanxi Sanqin deputy general manager Chang Weijuan, Technical Center director Zuo Wujun and Comprehensive Department assistant Hou Fang, and INCSMM Administrative Office director Yang Xiaogang, research assistant Wang Pei participated in the talks.

富阎产业合作园区来访

Fuyan Industrial Cooperation Park visitors received

2023 年 1 月 18 日，富阎产业合作园区党工委副书记、管委会主任杜银虎一行到访参观了新概念传感器与分子材料研究院，并与房喻院士进行了会谈交流。

富阎产业合作园区招商二局局长任劼、党政办公室高级主管巨博、招商二局干部孙甜，新概念传感器与分子材料研究院副院长丁立平教授、办公室主任杨小刚和彭军霞教授参加了会谈交流。

On January 18, 2023, guests led by Du Yinhu, deputy secretary of the Party Work Committee and director of the Management Committee of Fuyan Industrial Cooperation Park, visited the Institute of New Concept Sensors and Molecular Materials and had talks with Prof. Fang Yu.

Fuyan Industrial Cooperation Park Second Bureau of Investment Promotion director Ren Jie, Party Affairs and Administrative Office senior director Ju Bo, and Second Bureau of Investment Promotion staffer Sun Tian, and INCSMM vice dean Prof. Ding Liping, Administrative Office director Yang Xiaogang, and Prof. Peng Junxia participated in the talks.

总策划：房喻教授
Producer & Editor-in-Chief: Prof. Fang Yu
责任编辑：刘凯强 冯伟
Executive Editors: Liu Kaiqiang, Feng Wei
翻译：冯伟
Translator: Feng Wei
校对：团队全体老师
Proofreading: Fang Group teachers

地址：陕西省西安市长安区西长安街 620 号陕西师范大学长安校区
Chang'an Campus, Shaanxi Normal University, 620 West Chang'an Avenue, Chang'an District, Xi'an, Shaanxi, P. R. China
联系电话 (Tel)：86-29-81530726
电子邮箱 (Email)：incsmm@snnu.edu.cn

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