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SHAANXI NORMAL UNIVERSITY

化学化工学院
School of Chemistry & Chemical Engineering

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简报
Newsletter

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

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房喻院士出席中国化学会第三十一届常务理事会第三次现场会议

Fang Yu attends Third On-site Meeting of 31st CCS Standing Council

2025 年 2 月 23 日，中国化学会第三十一届常务理事会第三次现场会议在北京召开，房喻院士作为常务理事出席会议。

理事长万立骏院士主持此次理事会议并作《中国化学会 2024 年工作报告》，36 位常务理事、7 位监事会成员参加会议，秘书长班子成员及秘书处成员列席会议。

On February 23, 2025, Prof. Fang Yu attended the Third On-site Meeting of the 31st Standing Council of the Chinese Chemical Society held in Beijing as a standing director.

The chairman, Academician Wan Lijun, presided over the council meeting and made the Report on the Work of the Chinese Chemical Society in 2024. Thirty six standing directors and 7 members of the Board of Supervisors attended the meeting, and members of the Secretary-General’s team and the Secretariat attended the meeting.

房喻院士和彭浩南教授访问精准智能化学全国重点实验室

Fang Yu and Peng Haonan visit National Key Laboratory of Precision and Intelligent Chemistry

2025 年 2 月 24 日，应中国科学技术大学邀请，新概念传感器与分子材料研究院房喻院士和彭浩南教授访问了精准智能化学全国重点实验室，双方围绕智能化学研究的前沿技术、交叉学科创新及未来合作方向进行了交流。

访问期间，房喻院士和彭浩南教授参观了实验室的智能化学实验平台及 AI 辅助分析系统，对实验室在精准分子设计、智能材料开发等领域取得的突破性成果表示高度赞赏。

此次访问为深化跨学科融合、加速智能化学技术落地提供了新契机，双方将依托各自优势，共同推进“化学+AI”研究范式革新。

On February 24, 2025, at the invitation of the University of Science and Technology of China, Prof. Fang Yu and Prof. Peng Haonan of the Institute of New Concept Sensors and Molecular Materials visited the National Key Laboratory of Precision and Intelligent Chemistry (NKLPC), where the two

sides exchanged views on the cutting-edge technologies, cross-disciplinary innovations, and future directions of cooperation in the research of intelligent chemistry.

During the visit, Fang Yu and Peng Haonan visited the laboratory's intelligent chemistry experiment platform and AI-assisted analysis system, and highly appreciated the laboratory's breakthrough achievements in the fields of precise molecular design and intelligent materials development.

This visit provides a new opportunity to deepen interdisciplinary integration and accelerate the realization of intelligent chemistry technology, and the two sides will rely on their respective strengths to jointly promote the innovation of "Chemistry + AI" research paradigm.

研究院 STPS 防水拒油透气膜技术及产业化项目亮相陕西省科技金融融资对接会

INCSMM STPS membrane technology and industrialization project showcased at Shaanxi S&T Financing Docking Roadshow

2025 年 2 月 26 日，陕西省科技金融融资对接会在西咸新区秦创原金融中心举办，新概念传感器与分子材料研究院 STPS 防水拒油透气膜技术及产业化作为五个受邀路演项目之一亮相路演活动。

研究院副院长丁立平教授、刘凯强教授、对外联络与行政办公室主任杨小刚和专职科研人员王佩参加了路演活动。王佩向与会嘉宾详细介绍了 STPS 防水拒油透气膜技术的核心优势、研发历程及产业化前景。

该项目是房喻院士团队基于国际领先的凝胶乳液软模板制备技术研发的一类透气性大范围可调、组分功能化复合等突出优势的 STPS 防水拒油透气膜新材料。生产工艺具有技术先进、结构精准调控和表界面定制化修饰三大技术优势，攻克了放大制备、稳定化生产、绿色环保、成本控制四大生产难题。产品可在汽车、户外电子设备、智能家居家电、光伏及储能、日用化工和医疗等行业广泛应用。

此次活动由陕西省科技厅联合省委金融办等单位组织，30 家政府部门，20 家金融机构，20 家投资机构，20 家高校院所，30 家科技型企业及多家新闻媒体参加了此次活动。

On February 26, 2025, Shaanxi Province Science and Technology Financing Matchmaking Meeting was held in Qinchuangyuan Financial Center of Xixian New District, and Institute of New Concept Sensors and Molecular Materials' STPS (Soft Template-based Polystyrene Foam) waterproof oil-repellent and breathable membrane technology and industrialization project showcased at the roadshow as one of the five invited projects.

INCSMM vice dean Prof. Ding Liping, Prof. Liu Kaiqiang, Liaison and Administration Office director Yang Xiaogang, and research assistant Wang Pei attended the roadshow. Wang Pei introduced the core advantages, R&D history and industrialization prospect of STPS waterproof oil-repellent breathable membrane technology to the audience in detail.

This project is based on the international leading gel emulsion soft template preparation technology developed by Prof. Fang Yu's team, which is a class of STPS waterproof oil-repellent breathable membrane new materials with the outstanding advantages of wide range of adjustable air permeability and functional composition composite. Its production process has three technical advantages: advanced technology, precise structural control and customized modification of the surface interface, and has overcome four major production problems: amplified preparation, stabilized production, green environmental protection and cost control. The products can be widely used in automotive, outdoor electronic equipment, smart home appliances, photovoltaic and energy storage, daily-use chemical and medical industries.

Thirty government departments, 20 financial institutions, 20 investment institutions, 20 universities and institutes, 30 science and technology-based enterprises and a number of news media participated in the event organized by Shaanxi Provincial Department of Science and Technology in conjunction with the Shaanxi Provincial Party Committee Finance Office.

房喻院士出席西北核技术研究所学术年会并作报告

Fang Yu speaks at annual conference of Northwest Institute of Nuclear Technology

2025 年 2 月 26 日，房喻院士应邀出席西北核技术研究所第六届学术年会，并作题为《创新驱动发展需要更加重视重大需求牵引的长周期基础研究》的专题报告。

On February 26, 2025, Prof. Fang Yu was invited to attend the sixth academic annual meeting of Northwest Institute of Nuclear Technology, and gave a special report titled “Innovation-driven Development Needs to Pay More Attention to Long-term Basic Research Driven by Major Needs”.

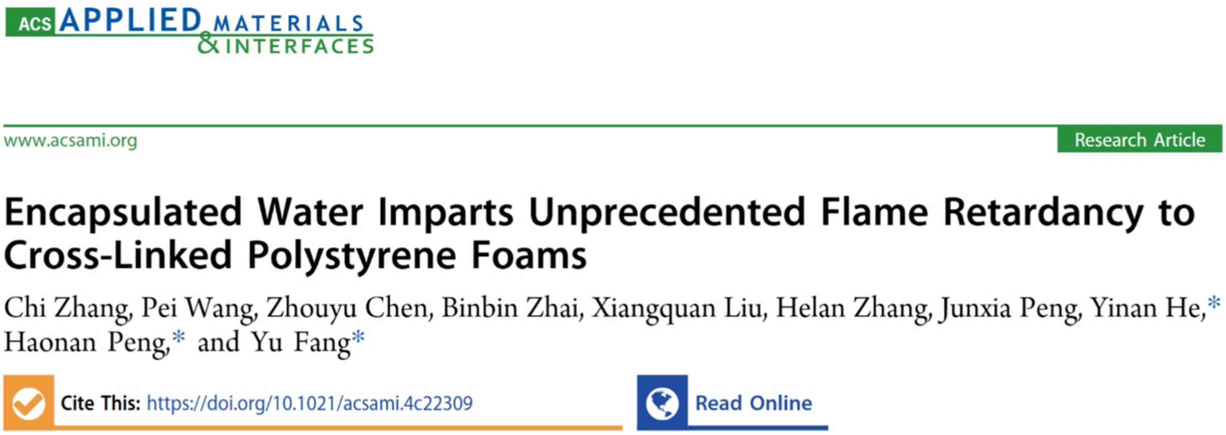
院友动态 Alumni News

院友王照娟的课程入选教育部基础教育部级精品课

Alumna Wang Zhaojuan’s course selected as Ministry-level Quality Course of Ministry of Education

近日，新概念传感器与分子材料研究院 2022 届物理化学专业硕士毕业生、西北农林科技大学附属中学化学教师王照娟老师与同为陕西师范大学化学专业毕业生的赵晨帆老师合作的课程《科学护齿——基于手持技术的沉淀溶解平衡探究》入选教育部基础教育“部级精品课”名单。

Recently, the course “Scientific Mouth Care - Exploration of Precipitation Dissolution Balance Based on Handheld Technology” co-authored by Ms. Wang Zhaojuan, a Class 2022 master’s degree graduate of Physical Chemistry of the Institute of New Concept Sensors and Molecular Materials, and Ms. Zhao Chenfan, also a chemistry graduate of Shaanxi Normal University, both are now chemistry teachers of the Affiliated Middle School of Northwest A & F University, was selected in the list of “Ministerial Quality Courses” in Basic Education of the Ministry of Education.



ACS APPLIED MATERIALS & INTERFACES

www.acsami.org Research Article

Encapsulated Water Imparts Unprecedented Flame Retardancy to Cross-Linked Polystyrene Foams

Chi Zhang, Pei Wang, Zhouyu Chen, Binbin Zhai, Xiangquan Liu, Helan Zhang, Junxia Peng, Yinan He,* Haonan Peng,* and Yu Fang*

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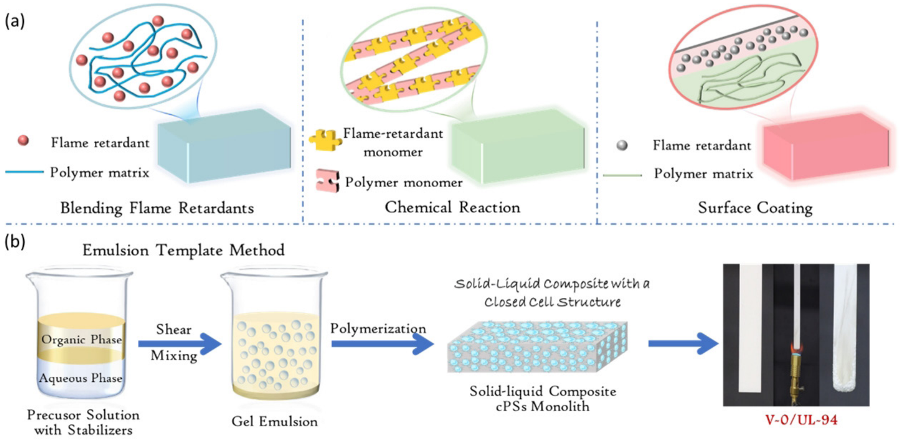
包封水赋予交联聚苯乙烯泡沫突破性阻燃性能

Chi Zhang, Pei Wang, Zhouyu Chen, Binbin Zhai, Xiangquan Liu, Helan Zhang, Junxia Peng, Yinan He, Haonan Peng, and Yu Fang, ACS Applied Materials & Interfaces 2025, DOI: 10.1021/acsami.4c22309.



聚合物材料因其轻便、高强度和耐腐蚀性，广泛应用于制造业、农业、交通运输及电子电器等领域。然而，聚合物具有高度可燃性，点火点低，易于迅速着火并释放有害气体，带来严重的安全隐患。因此，提升聚合物的阻燃性能至关重要。当前主要的阻燃策略包括：物理共混法、化学交联法以及表面涂层法。这些方法虽然有效但却存在环境污染、成本高昂及涂层易损等问题，亟需新的环保阻燃策略。水作为一种低成本、环保且不燃烧的物质，为开发新型阻燃聚合物提供了潜力。通过凝胶乳液模板法，水可以在聚合物基体中实现微纳米级的均匀分散，形成固–液复合材料。该方法通过平衡 Marangoni 效应和 Ostwald 熟化效应调控孔隙结构，有效包封水滴进而提升材料阻燃性能，为开发环保聚合物材料提供了有效途径。

在本研究中，我们首次利用水作为阻燃剂，通过凝胶乳液模板法成功制备了基于交联聚苯乙烯泡沫（cPSs）的固–液复合材料，该材料具有完全封闭的孔道结构。在 UL–94 测试中，所制备的固–液复合材料展现出优异的阻燃性能，阻燃等级达到 V–0 级。峰值热释放速率（PHRR）和总热释放量（THR）显著降低，点火时间（TTI）和火焰性能指数（FPI）分别增加了 10 倍以上和 25 倍以上。通过在材料表面施用厚度仅为微米级的防水涂层并选用加盐水代替纯水，我们实现了超八年的耐久性阻燃效果，不同于传统阻燃策略，本研究将水作为阻燃剂整合到材料内部，利用水的高比热、高汽化热的特点，通过冷却、稀释和窒息效应实现了材料的绿色高效阻燃。这一研究成果不仅为开发具有革命性

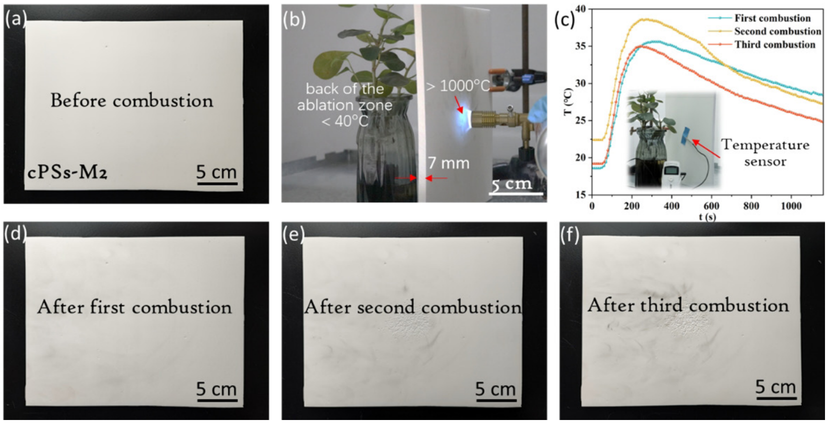


图 1.cPSs-M2 材料在燃烧测试中的外观变化及耐热性能

Figure 1. The appearance changes and thermal resistance performance of cPSs-M2 in combustion tests.

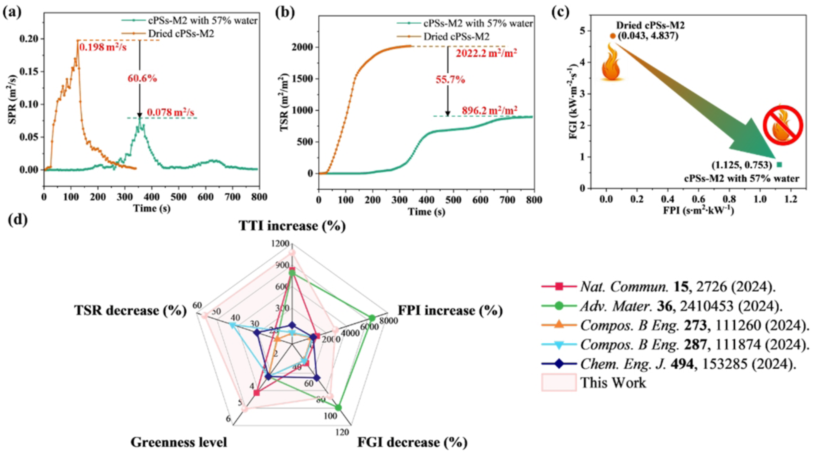


图 2.cPSs-M2 材料的阻燃性能及性能对比

Figure 2. The flame retardant properties and performance comparison of cPSs-M2.

意义的新型环保阻燃材料奠定了基础，而且在实际应用中展现出巨大的商业化潜力和广阔的前景。

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Polymer materials, with their advantages of light weight, high strength, and corrosion resistance, are widely used in manufacturing, agriculture, transportation, and electronic appliances. However, polymers are highly flammable, with a low ignition point, prone to rapid ignition and the release of harmful gases, posing significant safety hazards. Therefore, enhancing the flame retardancy of polymers is of paramount importance. Current primary flame-retardant strategies include physical blending, chemical crosslinking, and surface coating methods. However, these approaches face issues such as environmental pollution, high costs, and vulnerable coatings, necessitating the development of novel eco-friendly flame-retardant strategies. Water, as a low-cost, environmentally friendly, and non-flammable substance, offers great potential for developing innovative flame-retardant polymers. Using the emulsion-templating method, water can be uniformly dispersed in a polymer matrix at the micro-to-nano scale, forming solid-liquid composite materials. This method, through the regulation of pore structures and balancing the Marangoni effect and Ostwald ripening effect, effectively enhances the flame retardancy of the material, providing a promising pathway for developing eco-friendly polymer materials.

In this study, we pioneered the use of water as a flame retardant, successfully preparing solid-liquid composite materials based on crosslinked polystyrene foam (cPSs) using the emulsion-templating method. These materials exhibit a fully enclosed pore structure. In UL-94 testing, the solid-liquid composites demonstrated exceptional flame-retardant performance, achieving a flame resistance rating of V-0. The peak heat release rate (PHRR) and total heat release (THR) were significantly reduced, while the ignition time (TTI) and flame performance index (FPI) were increased by more than 10 times and 25 times, respectively. By applying a micrometer-thick hydrophobic coating to the material surface and using saltwater instead of pure water, we achieved flame-retardant durability exceeding eight years. Unlike traditional flame-retardant strategies, this study integrates water as a flame retardant into the material interior, leveraging water's high specific heat and heat of vaporization to achieve green and efficient flame retardancy through cooling, dilution, and smothering effects. This research not only lays the foundation for the development of revolutionary, novel eco-friendly flame-retardant materials but also demonstrates tremendous commercial potential and broad prospects in practical applications.

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Research Article

Manipulating Constitutional Isomerism of Imine Linkages in Interfacially Confined Nanofilms toward Enhanced Fluorescence Sensing

Jiang Feng, Haixia Chang, Xingtong Zhou, Shouxin Zhang,* Liping Ding,* Taihong Liu,* and Yu Fang

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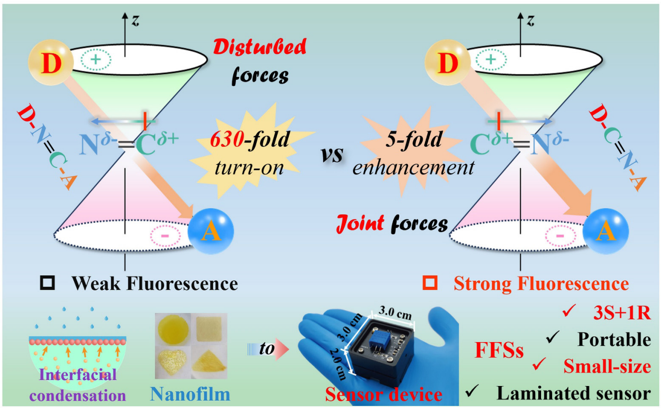
界面限域纳米薄膜中亚胺键异构化及荧光传感应用

Jiang Feng, Haixia Chang, Xingtong Zhou, Shouxin Zhang,* Liping Ding,* Taihong Liu,* and Yu Fang. ACS Appl. Mater. Interfaces, 2025, DOI: 10.1021/acsami.5c00028



二维共价有机框架（2D COF）是一类综合性能优异但又充满挑战的新型多孔晶体材料，具有可定制组装类型、扩展 π 共轭和高度有序网络结构等特性，在包括催化、分离、储能、传感等领域展现出了独特优势。大量研究表明，Donor–π–Acceptor 型二维共价有机框架材料的光致发光和光电性能不可避免地由骨架单元和 π 键特性决定，同时分子内电子/电荷转移、分子间弱相互作用等亦决定性地影响着二维共价有机框架材料的光电性能。在优选 D 和 A 构建单元的前提下，与 π 键类型不同，特定 π 键的偶极矩取向亦影响着二维共价有机框架的光物理性质。以席夫碱型亚胺键 C=N 为例，即使连接相同的 D/A 构建单元，仍有 D–C=N–A 和 D–N=C–A 两种不同构型。因此，分子内电荷转移程度取决于亚胺共轭取向和扭转角，势必影响制备得到的框架材料的光物理性质，是基本层面的重要分子构效研究，具有重要研究指导意义。

本工作基于气–液界面限域动态缩合制备策略，分别以四苯乙烯 TPE 为电子供体 D 和苯并 [c][1,2,5] 噻二唑 BT 为电子受体 A 作为骨架单元制备了两种结构差别细微的纳米薄膜，分别命名为 TPE–C=N–BT 和 TPE–N=C–BT。两种薄膜的制备过程均得到了 AFM、SEM、TEM、XPS 等技术的系统表征。同时借助 UV–Vis、荧光等稳态光谱技术和超快瞬态吸收技光谱技术对纳米薄膜的光物理性质进行了对比研究。研究表明，纳米薄膜的 π 电子离域程度取决于亚胺键的不同偶极矩取向，影响着纳米薄膜的本征光物理性质及其对气相三氟乙酸（TFA）的荧光传感。TPE–C=N–BT 结构纳米膜 #2 比具有 TPE–N=C–BT 结构的纳米膜 #1 产生相对更强的本征荧光；基于胺基传感结合位点和纳米膜较大的比表面对传质作用的促进，具有 TPE–N=C–BT 结构的纳米膜 #1 对一定浓度的气相 TFA 表现出约 630 倍的显著荧光增强，远大于同等条件的 TPE–C=N–BT 结构纳米膜 #2。超快瞬态光谱测试和 DFT 理论计算均阐明了亚胺连接构型的功能单元间分子内电荷转移 ICT 效率的有效调控。

立足实验室叠层式薄膜荧光传感器新结构和薄膜基荧光传感原理平台，优选的纳米薄膜 #1 对 TFA 气相传感表现出良好的选择性、优异的可逆性、较低的检测限 ~ 0.1ppt 和快速可逆性。研究结果为二维共价有机框架 2D COF 中 π 键构型和偶极取向研究提供了范例指导，并为有毒有害物质的气相荧光薄膜检测提供了参考。

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Photoluminescence efficiencies of covalent organic frameworks (COFs) are significantly restricted by the electron delocalization and charge transfer among the conjugated skeletons. Aiming to evaluate the inherent effect of imine sequences on the photophysical

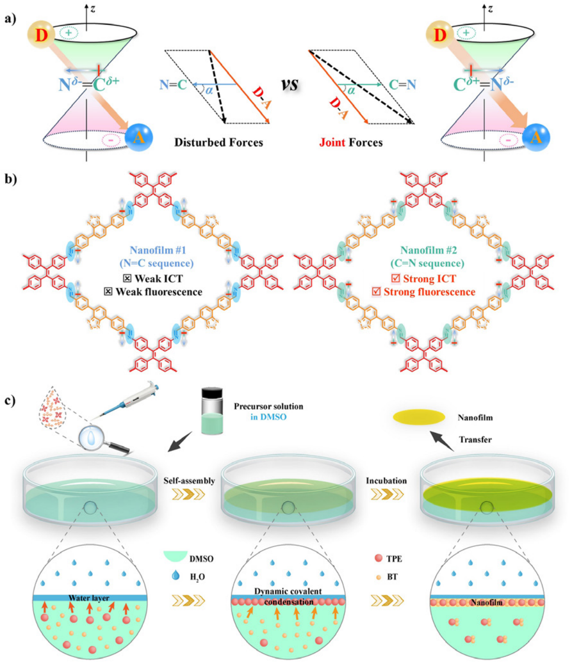

图 1.（a）具有不同亚胺键构型的两种纳米薄膜结构示意图；（b）不同偶极矩取向对两种 D－π－A 型薄膜结构的影响本质分析；（c）基于气－液界面限域动态缩合策略制备纳米薄膜的流程示意图。

Figure 1. (a) Schematic diagrams of the constitutional isomerism of imine linkages with the distinct dipole moment orientations. (b) Frameworks of the nanofilm #1 featuring the disturbed D-N=C-A sequence and the nanofilm #2 featuring the joint D-C=N-A sequence. (c) Schematic illustration for preparing the nanofilms via the air-liquid interfacially confined dynamic condensation strategy.

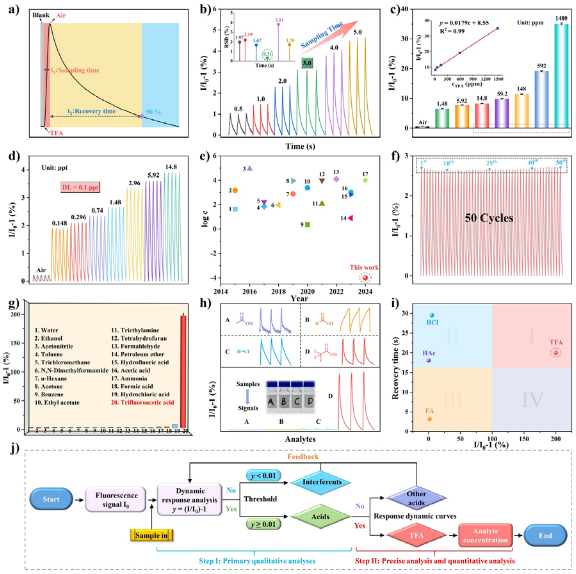

图 2. 基于叠层式薄膜荧光传感器平台的传感测试结果分析和区分检测。

Figure 2. Sensing and discrimination performances of the nanofilms to gaseous TFA based on the home-made sensing platform.

properties of the generated frameworks, two nanofilms (denoted as the nanofilms #1 and #2) were prepared based on the air-liquid interfacially confined dynamic condensation strategy using the same building skeletons, tetraphenylethylene (TPE) and benzo[c][1,2,5]thiadiazole (BT). To be noted, the AIEgen TPE and BT acted as the D and A groups, respectively, and the imine group could be functioned as an emission mediator and a recognition site for sensing applications. The nanofilms' properties were systematically characterized and comprehensively investigated using the steady-state optical techniques and ultrafast transient absorption.

The nanofilm #1 displayed a steady-state absorption maximum around 410 nm corresponding to the π-π* transitions. Additional strong and narrow short-wavelength absorption bands were also found around 320 nm. Specifically, the nanofilm #2 featured the absorption maximum around 430 nm. The spectral red-shift (Δλ ~ 20 nm) reflected the slightly extended π-delocalization of D-A conjugation as well as the enhanced π-π transition in the nanofilm #2 featuring the D-C=N-A sequence. The increased optical energy gaps from ~ 2.23 eV for the nanofilm #1 to that of ~ 2.35 eV for the nanofilm #2 supported efficient ICT in the joint D-C=N-A sequence. It suggested that the joint D-C=N-A sequence produced a little stronger electron transfer capability than the contrastive D-N=C-A sequence as expected. The ICT and fluorescence properties of these nanofilms were also seriously influenced by the imine sequences. As reported, the plausible PET and cis-trans isomerization process of C=N effects generally resulted in the non-fluorescent or less-emissive characteristics.

The distinct dipole moment orientations of imine linkages involved in the π-delocalization of conjugated donor-acceptor systems diversely. They also played critical roles in affecting the fluorescence turn-on sensing of the obtained nanofilms for gaseous trifluoroacetic acid (TFA). The joint donor-C=N-acceptor sequence in the nanofilm #2 resulted in relatively stronger fluorescence originally than that of the nanofilm #1 featuring the disturbed donor-N=C-acceptor sequence. While after blowing trace TFA, the latter nanofilm #1 possessed prominent fluorescence enhancement and obviously color visualization. Comparative transient absorption observations and theoretical calculations elucidated the effective manipulation of the ICT efficiencies among the imine-linked functional skeletons.

With the help of a laminated fluorescent sensor, a compact sensing platform was further integrated using the optimized nanofilm #1. It exhibited good selectivity, excellent reversibility (≥ 50 recycles), extraordinary detection limit (~ 0.1 ppt), and rapid recovery process to gaseous TFA. In-depth analysis of the recovery time on the sensing curves of TFA and other acid interferences, a clear discrimination among them could be conducted. Our findings provide the valuable optimizations of π-linkages in COFs and reliable fluorescent film sensors for monitoring toxic and hazardous gases.

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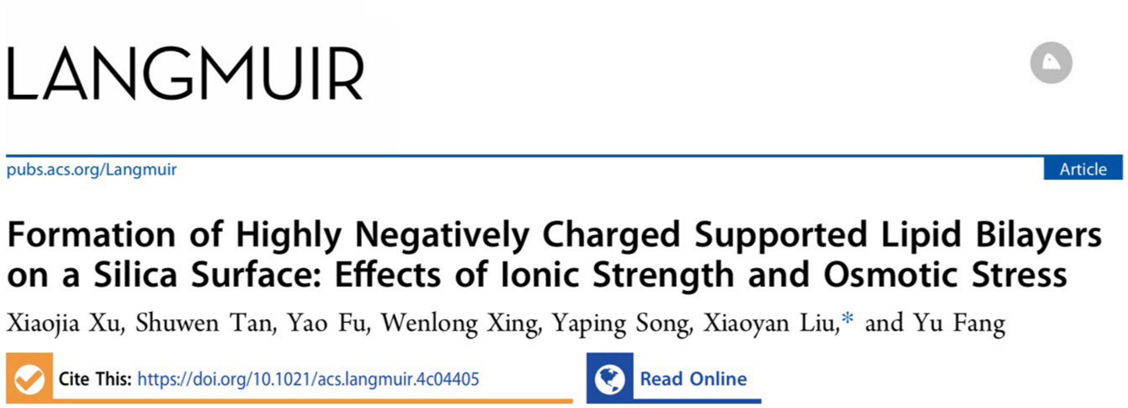

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Formation of Highly Negatively Charged Supported Lipid Bilayers on a Silica Surface: Effects of Ionic Strength and Osmotic Stress

Xiaojia Xu, Shuwen Tan, Yao Fu, Wenlong Xing, Yaping Song, Xiaoyan Liu,* and Yu Fang

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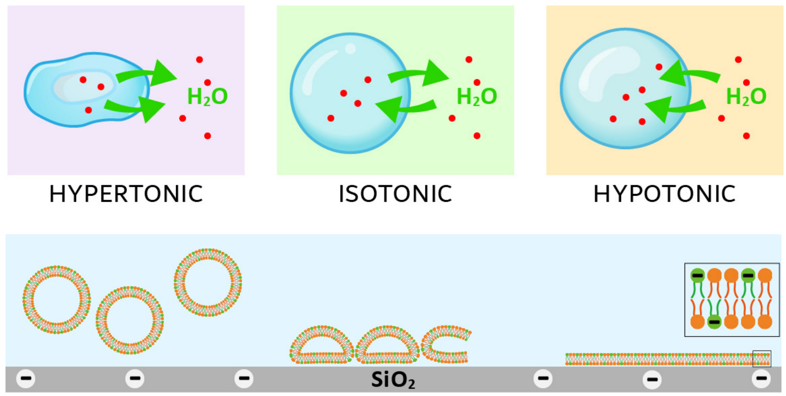
渗透压驱动构建强负电性平面型磷脂膜

Xiaojia Xu, Shuwen Tan, Yao Fu, Wenlong Xing, Yaping Song, Xiaoyan Liu*, Yu Fang. Langmuir 2025, 10.1021/acs.langmuir.4c04405



平面型脂质双层膜（SLBs）作为模型细胞膜在生物物理研究方面具有广泛应用。然而，由于静电排斥作用，在带负电表面上制备高负电荷SLBs仍然具有很大挑战。

此研究致力于通过调节离子强度和渗透压差在二氧化硅表面构建强负电性SLBs。通过石英晶体微天平（QCM-D）研究了高负电荷囊泡在不同NaCl浓度和渗透压条件下在二氧化硅表面上的吸附与融合过程。结果表明，增大溶液的离子强度能够显著促进SLB的形成，正渗透压和中等的负渗透压条件下均可促进SLB的形成，然而，在高的负渗透压条件下无法形成SLB。并且发现，仅通过改变渗透压差而不改变离子强度不能促进SLB的形成。此外，原子力显微镜形貌图显示，在正渗透压和高离子强度条件下形成的脂质双层膜具有很好的完整性，而在负渗透压条件下形成的双层膜中存在缺陷。光漂白荧光恢复实验表明完整的脂质双层膜相比于存在缺陷的双层膜具有更高的流动性。

此研究为在制备负电性平面型模型细胞膜提供了新的理解，对其在生物传感器和药物载体等领域应用具有重要的意义。

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Solid supported lipid bilayers (SLBs) serve as an excellent platform for biophysical studies. However, the formation of highly negatively charged SLBs on negatively charged surfaces remains a challenge due to electrostatic repulsion. The study employed two methods for applying osmotic pressure: altering the ion strength on one side while maintaining constant ion strength on the vesicle's interior or exterior. Here, we study the effects of ionic strength and osmotic stress on the formation of highly negatively charged SLBs on the silica surface. We used quartz crystal microbalance-dissipation to study the adsorption and rupture of highly negatively charged small unilamellar vesicles on the silica surface in different concentrations of NaCl and under different osmotic stresses.

It was demonstrated that an increase in the ionic strength of the solution enhances SLB formation. Both hypertonic and moderate hypotonic osmotic stress can promote the formation of SLBs. However, the SLB cannot be formed under high hypotonic osmotic stress. Importantly, osmotic stress alone without a change in ionic strength is insufficient to promote SLB formation. Moreover, the topographical images obtained by atomic force microscopy showed that complete bilayers were formed under hypertonic osmotic stress and high ionic strength, whereas defects were noticed in the bilayers formed under hypotonic osmotic stress. Furthermore, the fluidity of the lipid bilayers was studied by fluorescence recovery after photo bleaching. A higher membrane fluidity was observed for the complete lipid bilayers compared to that

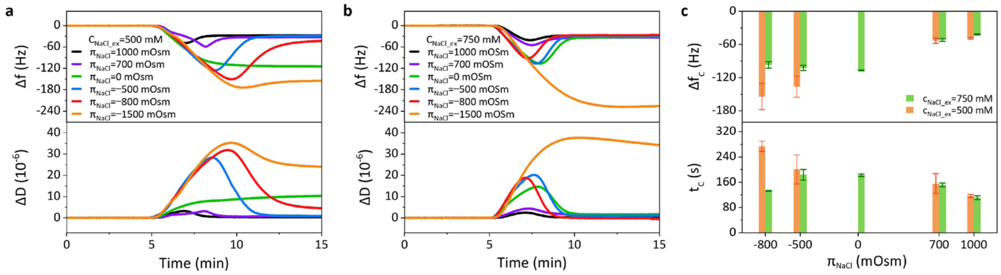

图 1. Δf 和 ΔD 随时间变化，表明了 DOPC/DOPS 脂质体在不同渗透压（πNaCl）下吸附和融合的过程，(a) 500 mM，(b) 750 mM。(c) 在不同渗透压下形成 SLBs 时 ΔfC 和 tC 的变化。

Figure 1. Δf and ΔD as a function of time during adsorption and rupture of the DOPC/DOPS vesicleson the silica surface under different osmotic stresses (πNaCl). The osmotic stress was generated by the method in which the NaCl concentrationoutside the vesicles (CNaCl_ex) was fixed to (a) 500 mM and (b) 750 mM. (c) Δf C and tC during the formation of the SLBs under different osmotic stresses.

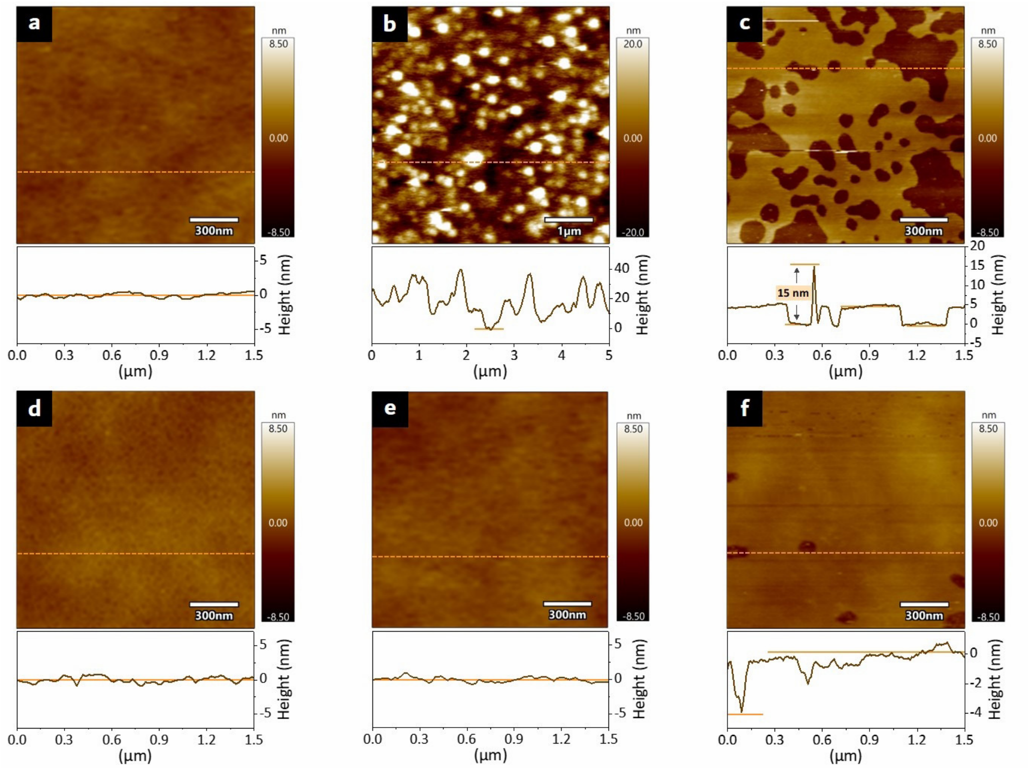

图 2. 在不同渗透压下由囊泡形成的 SLBs 的 AFM 图像，[(a 和 d) 正渗（π_{NaCl} = 1000 mOsm), (b 和 e) 等渗，(c 和 f) 负渗（π_{NaCl} = −800 mOsm)]，其中囊泡外部的 NaCl 浓度保持恒定 [(a–c) C_{NaCl_ex} = 500 mM, (d–f) C_{NaCl_ex} = 750 mM]。截面分析显示了高度图中相应线条的高度分布。

Figure 1. AFM height images of the SLBs formed by the vesicles under different osmotic stresses [(a and d) hypertonic (π_{NaCl} = 1000 mOsm), (b and e) isotonic, and (c and f) hypotonic (π_{NaCl} = −800 mOsm)] with the NaCl concentration outside the vesicles kept constant [(a–c) C_{NaCl_ex} =500 mM, and (d–f) C_{NaCl_ex} = 750 mM]. The section analyses show the height profiles along the corresponding lines indicated in the height images.

of the lipid bilayers with defects. For preparing charged lipid membranes by applying osmotic stress, we recommend the internal method due to its narrower ionic strength range and simpler operation. To determine the mechanism of charged lipid bilayer formation with a change in osmotic stress, the external method should be used because it enables us to distinguish the effects of electrostatic interaction and osmotic stress. Our findings provide insights into the preparation of model cell membranes on solid surfaces and also have important biomedical implications, in areas such as biosensors and drug carriers.

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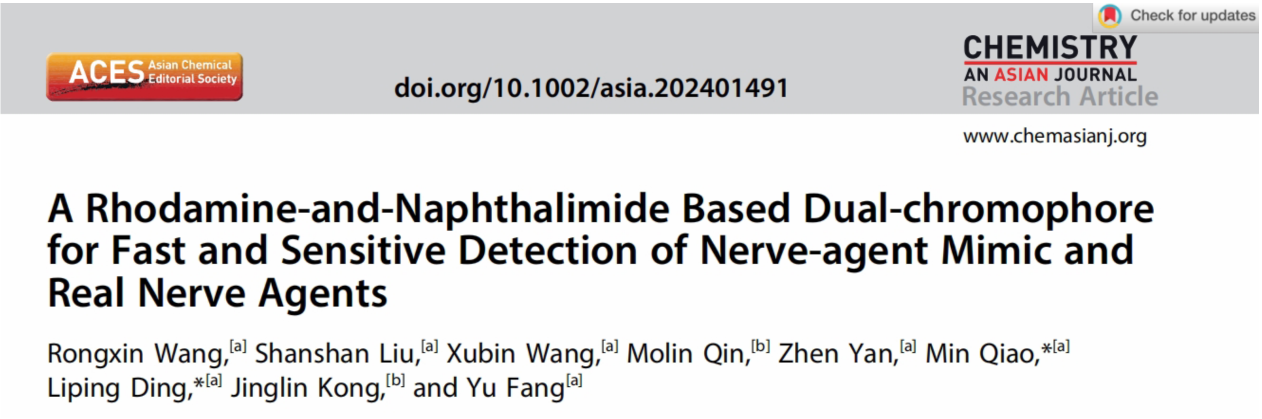
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A Rhodamine-and-Naphthalimide Based Dual-chromophore for Fast and Sensitive Detection of Nerve-agent Mimic and Real Nerve Agents

Rongxin Wang,[a] Shanshan Liu,[a] Xubin Wang,[a] Molin Qin,[b] Zhen Yan,[a] Min Qiao,*[a] Liping Ding,*[a] Jinglin Kong,[b] and Yu Fang[a]

一种基于罗丹明和萘酰亚胺的双发色团探针用于对神经毒剂及模拟物的快速灵敏检测

Rongxin Wang, Shanshan Liu, Xubin Wang, Molin Qin, Zhen Yan, Min Qiao*, Liping Ding*, Jinglin Kong, and Yu Fang. Chem Asian J. 2025, e202401491. DOI: 10.1002/asia.202401491.

神经毒剂是一种剧毒的有机磷化合物，常用于恐怖袭击和战争，威胁国家安全和公众健康。为了公共安全和公民健康，开发高效、便携的神经毒剂检测设备至关重要。许多荧光探针已被用于检测溶液或气相的神经毒剂模拟物氯磷酸二乙酯（DCP）。但有些仅限于液相检测，所选体系为有机溶剂或混合溶剂，限制了其在水溶液中的检测。

本研究合成了一种萘酰亚胺－罗丹明双发色团荧光分子 RNI–P，并将其应用于神经毒剂模拟物 DCP 和真实神经毒剂的检测。由于哌嗪和罗丹明单元到萘酰亚胺单元的 PET 过程，探针起始表现弱荧光。在水溶液中加入 DCP 后，荧光快速增强，表现出优异的灵敏度和选择性。此外，用该探针制备的试纸条集成到实验室自制的便携式传感平台，实现了对 DCP 蒸汽的快速响应。该纸条在 1 分钟内对低至

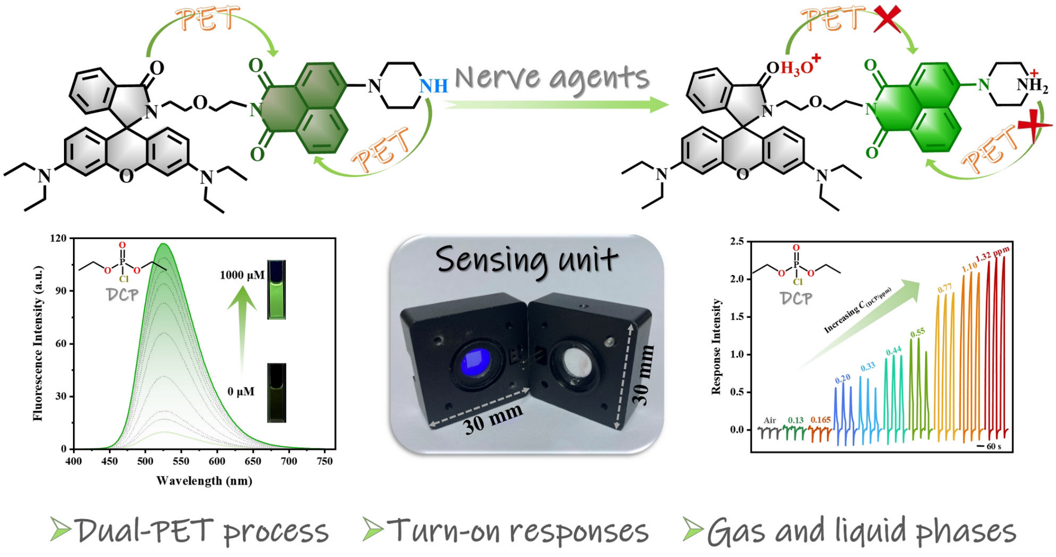

图 1.RNI−P 与 DCP 作用的示意图
Figure 1. Schematic diagram of the mechanism for OPs detection

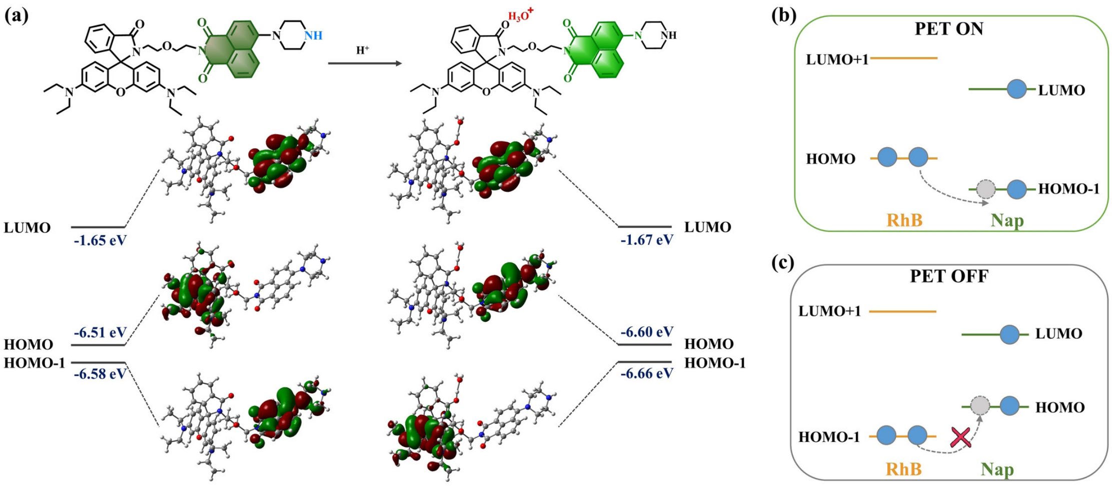

图 2.（a）RNI−P 和 RNI−P−H_3O^+ 在水中的前沿分子轨道分布和能量。RNI−P 光激发下的 PET 过程示意图：（b）无 H_3O^+；（c）在 H_3O^+ 存在下

Figure 2. (a) Calculated distributions and energies of frontier molecular orbitals for RNI-P and RNI-P-H_3O^+ in water. Schematic illustration of the PET process upon the photoexcitation of RNI-P: (b) in the absence of H_3O^+; (c) in the presence of H_3O^+.

130 ppb 的 DCP 表现出明显的荧光增强，并且通过调整测试条件可以有效检测更低浓度（66 ppb）的 DCP 蒸气。值得注意的是，该探针能够快速有效地检测水溶液中的沙林和索曼等真实的神经毒剂，显示了其在实际应用中的巨大潜力。其荧光增强由于 RNI−P 与 DCP 水解产物质子化引发的从哌嗪和罗丹明单元到萘酰亚胺单元的 PET 过程受到抑制（图 2）。该工作表明，PET 过程不仅可以发生在亲核基团与荧光团间，而且第二个荧光团也可以对核心发色团产生有效的抑制作用，从而提高探针检测神经毒剂的能力。

因此，本研究提出了一种高效、快速、可重复的神经毒剂水溶液和气相检测传感器，为实际应用中的便携式神经毒剂检测提供了一种可行的选择。

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Nerve agents (NAs) are highly toxic organophosphorus (OP) compounds that are often used in terrorist attacks and wars to threaten national security and public health. For the sake of public safety and citizen health, the development of efficient and portable detection devices to nerve agents is critical.

In this investigation, a naphthalimide-rhodamine based dual-chromophore, RNI-P, was synthesized and applied to detect nerve-agent mimic diethyl chlorophosphate (DCP) and real nerve agents. The probe exhibits inherently weak fluorescence due to the PET processes from both piperazine and rhodamine units to the naphthalimide unit. It shows rapid fluorescence enhancement to DCP in aqueous solution, demonstrating exceptional sensitivity and selectivity. Furthermore, the probe-inked paper strip can also rapidly respond to DCP vapor when integrated into a lab-made portable sensing platform. the paper strip can show significant fluorescence enhancement for DCP as low as 130 ppb within a minute, and can effectively detect DCP vapor at even lower concentration (66 ppb) by adjusting the testing conditions. Most notably, the probe is capable of quickly and effectively detecting real nerve agents such as sarin and soman in aqueous solution, highlighting its significant potential for practical use. It was proved that the fluorescence enhancement is attributable to the inhibition of the PET process from both piperazine and rhodamine units to the naphthalimide unit, triggered by the protonation of RNI-P with DCP hydrolysis product. This study reveals that not only the usual nucleophilic groups but also a second fluorophore can cause effective PET process to the core chromophore and empowers the probe with strong potential for efficient detection of nerve agents.

Therefore, this research presents a highly efficient, rapid responding, and repeatable sensor for the detection of nerve agents in both aqueous solutions and gas phases, offering a viable option for the portable detection of nerve agents in practical applications.

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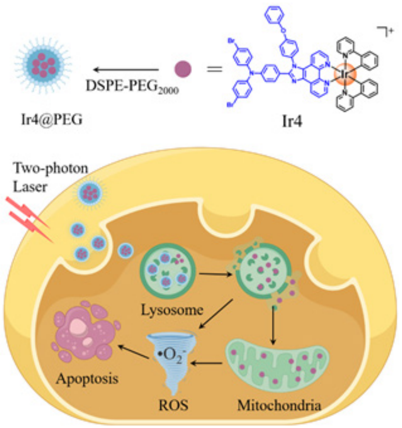
Mitochondria-localized dinuclear iridium(III) complexes for two-photon photodynamic therapy†

Zanru Tan,[a] Jiang Feng,[b] Jiangping Liu,*[c] Taihong Liu,*[b] Huihui Wu*[d] and Hui Chao*[a]

线粒体定位双核铱（III）配合物及双光子激发光动力治疗应用

Zanru Tan, Jiang Feng, Jiangping Liu,* Taihong Liu,* Huihui Wu*, Hui Chao*. Dalton Trans., 2025, DOI: 10.1039/D4DT03426K.



光动力学治疗 PDT 具有微创性、空间选择性和抗耐药性等优势，已成为一种很有前途的肿瘤临床治疗替代方案。PDT 方案涉及光敏剂 PS、激发光和氧气三个基本元素，光敏剂经过适当的光照激发后从基态跃迁至单线态，然后通过“系间穿越”跃迁至能量稍低的三线态。三线态再通过激发电子（I 型机制）或能量（II 型机制）与氧气作用产生活性氧物质（ROS）。这些 ROS 进一步氧化脂质、蛋白质和 DNA 等关键生物大分子，从而触发更深层次的生物化学反应并最终诱导目标细胞死亡。PDT 的三个基本元素中，光敏剂最为关键。目前 FDA 批准的卟啉和卟吩类光敏剂仍存在制备繁琐、光稳定性差和选择性不足等局限。因此，结构新颖的新型光敏剂的创新设计凸显出重要研究意义。

三价铱 Ir(III) 配合物因其良好的光物理特性、强光稳定性、易于合成和功能修饰等特点而被认为是抗癌治疗的理想候选药物。此外，环金属化 Ir(III) 配合物具有线粒体、内质网、溶酶体、高尔基体和细胞核等细胞区室的特异性积累特性，提供了一种活性氧诱导细胞毒性的新思路。在三价铱 Ir(III) 配合物结构设计方面，虽然单核 Ir(III) 配合物作为抗癌治疗光敏剂被广泛研究，但双核配合物的功能潜力在很大程度上仍未得到充分挖掘。近期研究结果表明，由柔性烷基链桥接的双核环金属化 Ir(III) 配合物在激发波长、光致发光量子产率和单线态氧量子产率等方面都优于其单核配合物。因此，系统考察一系列具有刚性桥接配体的新型双核 Ir(III) 配合物的光物理性质，优化其平面构型并最大程度提升其双光子吸收能力。另外需要说明的是，与单光子吸收相比，双光子激发光动力疗法提升了近红外激发波长和更深的组织穿透，同时具有三维空间定位功能。

此研究工作设计合成了四种新型双核 Ir(III) 配合物（图 1），并系统对比研究了它们的光物理特性、细胞光毒性和细胞成像结果。得益于有效的共轭程度扩展，该系列双核配合物的双光子激发光动力学治疗能力得到显著增强。

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PDT has emerged as a promising alternative in recent decades. In a PDT regimen, a photosensitizer (PS) absorbs light energy and transits to the excited state by which this energy (type II) or the excited electron (type I) is further shifted to the neighboring oxygen molecules, generating reactive oxygen species (ROS). These ROS oxidize pivotal macro-biomolecules, such as lipids, proteins, and DNA, triggering deeper biological responses and ultimately inducing cell death. Nevertheless, current commercially available PSs, such as porphyrin and chlorin derivatives, suffer from various

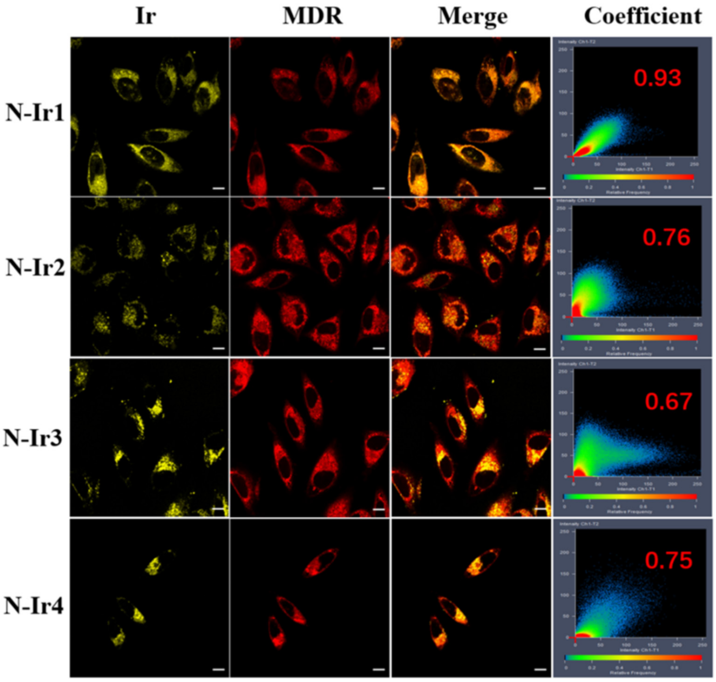

图 1. 双核铱 Ir(III) 配合物的化学结构及其在双光子激发 PDT 作用机制和细胞成像结果
Figure 1. Chemical structures of the Ir(III) complexes, the putative action mechanism in 2PA PDT and CLSM imaging of A375 cells incubated with the Ir(III) complexes

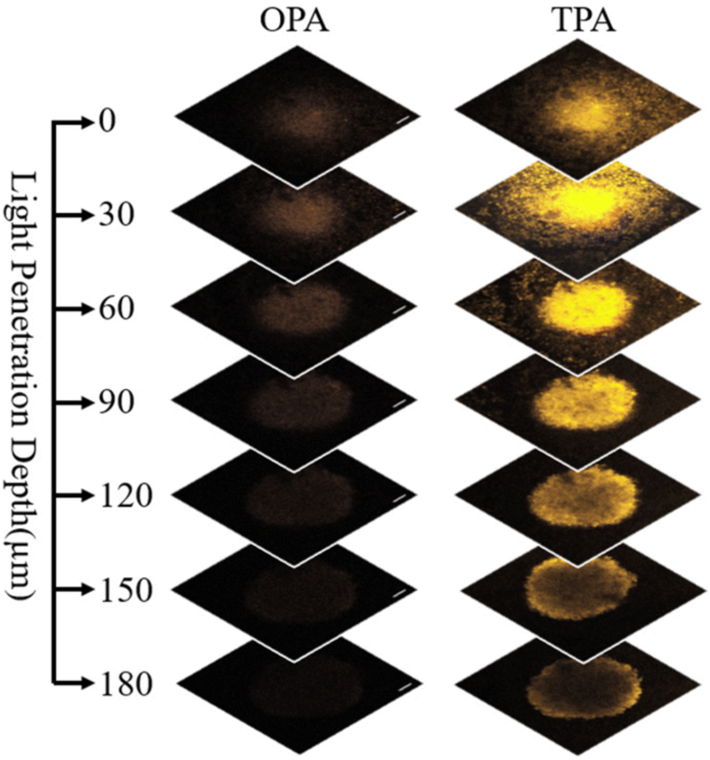

图 2. 单光子和双光子激发双核铱 Ir(III) 配合物在多细胞肿瘤球中的 3D 穿透深度对比（OPM 和 TPM 的激发波长分别为 405 nm 和 720 nm）
Figure 2. Penetration depth comparasion of the complexe N-Ir4 in 3D multi-cellular tumor spheroids upon one- or two-photon irradiation. The excitation wavelengths of OPM and TPM were 405 nm and 720 nm, respectively

limitations, including tedious preparation, poor photostability, and inadequate selectivity. Therefore, a novel class of PSs with bold structural novelty is highly demanded to push the envelope of this field.

Many Ir(III) complexes have been considered candidate drugs for anticancer therapy due to their favorable photophysical attributes and unique physiological properties, including strong photostability, ease of synthesis, and modifications. Besides, phosphorescent cyclometalated Ir(III) complexes often specifically accumulate in various cellular compartments such as mitochondria, endoplasmic reticulum, lysosomes, Golgi apparatus, and nuclei, providing a convenient way to induce cytotoxicity through the generation of ROS. Whilst mononuclear Ir(III) complexes have been extensively used as PSs for anticancer therapy, their dinuclear counterparts remain largely underexplored. A recent study suggested that a dinuclear cyclometalated Ir(III) complex in which the monomeric units were simply bridged by a flexible alkyl chain outperformed its mononuclear form in both photoluminescence quantum yield and singlet oxygen quantum yield. Indeed, homonuclear bimetallic complexes are often paired with interesting properties that are beyond the reach of their monomers. These advances prompt us to scrutinize the optical properties of a novel series of dinuclear Ir(III) complexes with rigid bridging ligands in which the optimized planar configuration may stand a chance to largely reshape its 2PA transition probabilities. The 2PA process involves the simultaneous absorption of two photons. Compared to single-photon absorption, 2PA offers an elegant way to excite Ir(III) complexes in the near-infrared regime and allows deeper tissue penetration for PDT applications.

Herein, a series of novel binuclear Ir(III) complexes were synthesized. In contrast to the routine multinuclear framework, the Ir(III) monomers were interfaced from the flank in an asymmetric manner via two large conjugate planes. Their photophysical properties and photocytotoxicity were investigated. Interestingly, benefiting from the potentially extended planar configuration, the dinuclear complexes feature significant enhancement in 2PA absorption compared to the reported mononuclear complexes.

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