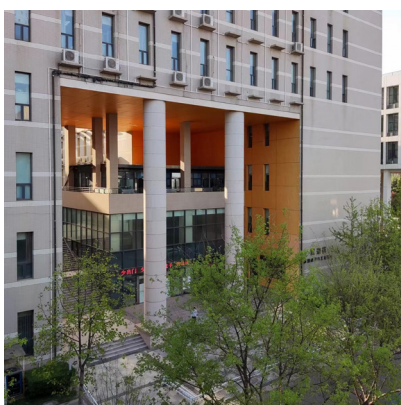
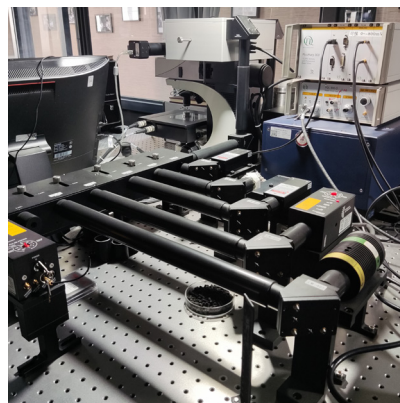
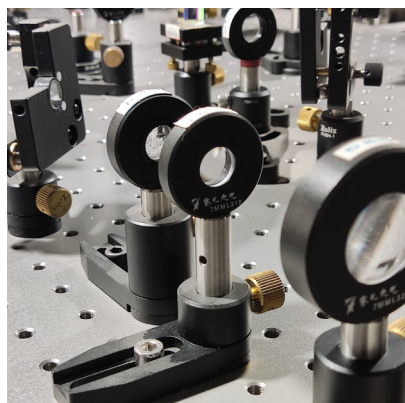
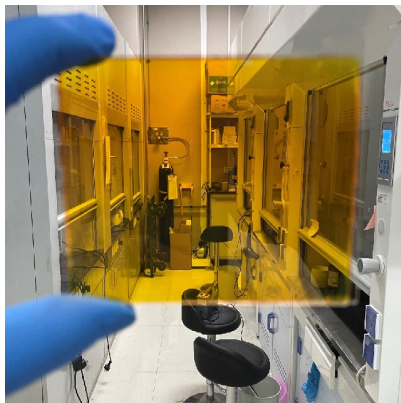


光子鼻与分子材料团队简报

Newsletter of Photonic Nose and Molecular Materials Group

3 / 2022



三月份大事记 Events in March, 2022

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房喻院士入选 2021 年度陕西省杰出人才 Fang Yu selected as an outstanding talent in 2021 Shaanxi Special Support Program



据陕西省委组织部人才工作处公布的消息，团队负责人房喻院士入选 2021 年度陕西省“特支计划”杰出人才。

此次共有 195 人入选陕西省“特支计划”，其中杰出人才 12 人，另有科技创新领军人才 46 人，科技创业领军人才 6 人，产业领军人才 17 人，哲学社会科学和文化艺术领域领军人才 10 人，教学名师 34 人，青年拔尖人才 40 人，区域发展人才 30 人。西安交通大学电子陶瓷与器件创新团队等 62 个团队入选陕西省“三秦学者”创新团队支持计划。

陕西省高层次人才特殊支持计划（简称“特支计划”）于 2020 年发布，是陕西省省级层面实施的重大人才工程，旨在围

绕陕西省追赶超越战略目标和落实“五新”战略任务，计划用 5 年左右时间，面向全省重点遴选 1500 名左右自然科学、工程技术和哲学社会科学领域的杰出人才、领军人才、青年拔尖人才和区域发展人才，给予特殊支持。

其中杰出人才采取“一事一议、按需支持”方式给予经费保障，实行人选专家负责制，支持其开展探索性、原创性研究，用于人才培养、团队建设等，并研究制定相应政策，在科研管理、事业平台、人事制度、经费使用、考核评价、激励保障等方面，制定落实重点培养支持政策。

According to the news released by the Talent Service Division of CPC Shaanxi

Committee's Organizational Department, Prof. Fang Yu is selected as an outstanding talent to be supported in Shaanxi province's "High-level Talents Special Support Program".

Of the 195 persons listed in the "Special Support Program", twelve are outstanding talents and the rest are leading talents in the categories of sci-tech innovation, sci-tech entrepreneurship, industry, philosophy, social sciences, culture and art, and teaching masters, young top-notch talents and regional development talents.

A provincial level major talent program launched in 2020, Shaanxi province's "High-level Talents Special Support Program" aims to select about 1500 talents and provide them with special support in five years time.

For outstanding talents, the selected experts will take charge and the fund will be allocated on a "Case by case, Support on demand" basis to support their exploratory original research and to be used in talent cultivation and team construction, with supportive policies in research management, R&D platform, personnel system, fund use, assessment and appraisal, and incentives, etc.

Exploring the Structure and Complexation Dynamics of Azide Anion Recognition by Calix[4]pyrroles in Solution

Dexia Zhou, Boxu Zhao, Yimin Bai, Somnath Mukherjee, Jing Liu,* Hongtao Bian,* and Yu Fang

Cite This: *J. Phys. Chem. Lett.* 2022, 13, 669–675

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溶液中离子识别结构动力学研究进展

离子的选择性识别在化学、生命科学等领域具有重要的研究意义，杯[4]吡咯及其衍生物作为一种典型的阴离子识别主体已成为超分子化学领域的研究热点。基于非共价键的动力学过程往往发生在超快的时间尺度（快于1纳秒， 10^{-9} s），受传统研究手段的局限，溶液中大环主体分子对阴离子的识别动力学及识别机理并未得到深入研究。近些年发展起来的具有飞秒（ 10^{-15} s）时间分辨能力的超快红外光谱技术已成功用于不同凝聚相体系中的分子动态结构解析及氢键交换动力学过程研究。本工作首次利用超快红外光谱研究了溶液中杯[4]吡咯主体分子识别 N_3^- 的超快动力学过程。结合密度泛函理论、核磁共振氢谱及转动动力学测量，发现线性 N_3^- 采用水平的方式与主体分子中的 N-H 形成分子间氢键， N_3^- 的转动时间常

数可用于定性表征阴离子与杯[4]吡咯主体分子形成的氢键个数。当溶液中存在 N_3^- 时，由于其与 N_3^- 有相对较强的静电相互作用，杯[4]吡咯的分子构象不一定从1,3交替转变为锥型构象来结合 N_3^- 。该工作为理解溶液中大环主体分子识别阴离子的微观机理提供了有益的动力学数据及研究思路。

研究亮点：

(1) 首次利用超快红外光谱研究了溶液中杯[4]吡咯主体分子识别 N_3^- 的超快动力学过程；

(2) 溶液中抗衡阳离子对杯[4]吡咯识别 N_3^- 的动力学过程有着显著影响，阴离子识别不一定会导致溶液中杯[4]吡咯主体分

子的构象从1,3交替转变为锥型（cone）结构；

(3) 转动动力学测量可用于定性表征阴离子与杯[4]吡咯主体分子形成的氢键个数。

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全文链接：<https://pubs.acs.org/doi/10.1021/acs.jpcl.1c03962>



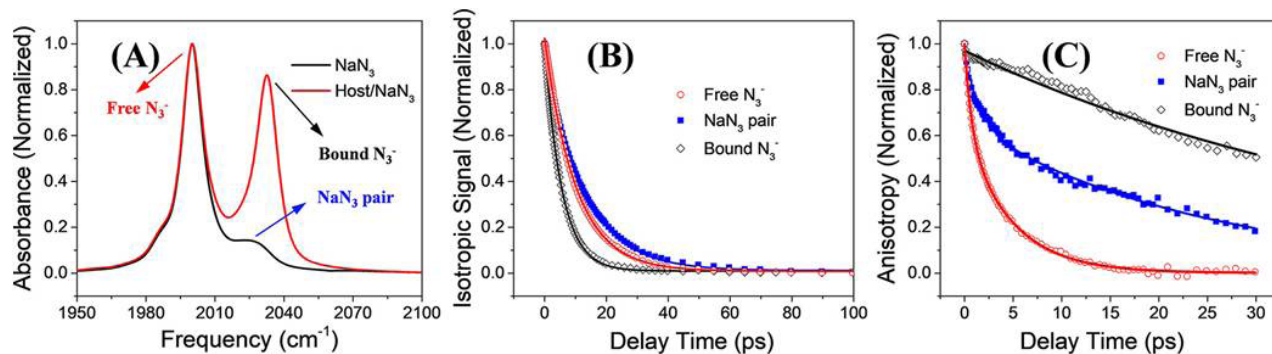


图 1. DMSO 溶液中杯 [4] 吡咯识别 N_3^- 阴离子的示意图。

Figure 1. Schematic representation of N_3^- anion recognition by calix[4]pyrroles in DMSO solution

The selective recognition of ions has important research significance in the fields of chemistry and life sciences. Calix[4]pyrrole and its derivatives, as a typical anion recognition host, have become a research hotspot in the field of supramolecular chemistry. Dynamics processes based on non-covalent bonds often occur on ultrafast time scales (faster than 1 nanosecond, 10^{-9} s). Due to the limitations of traditional research methods, the dynamics of anion recognition by macrocyclic host molecules in solution and the recognition mechanism has not been fully understood. In recent years, ultrafast infrared spectroscopy with femtosecond (10^{-15} s) time resolution has been successfully utilized for molecular dynamic structure analysis and hydrogen bond exchange dynamics in different condensed phase systems.

Research highlights:

1. This is the first experimental research that the ultrafast dynamics of calix[4]pyrrole host molecule recognizing N_3^- in solution was

studied by ultrafast infrared spectroscopy;

2. Countercations in solution have a significant impact on the dynamics of N_3^- recognition by calix[4]pyrrole, and anion recognition does not necessarily lead to the conformational transition of the calix[4]pyrrole host molecule from 1,3-alternate to cone conformation in solution.

3. Rotational kinetic measurements can be used to qualitatively characterize the number of hydrogen bonds formed between anions and calix[4]pyrrole host molecules.

In this study, N_3^- was used as a guest molecule and used as an infrared probe to reveal the ultrafast dynamics of ion recognition in solution. Structural optimization and frequency analysis of the studied host-guest complex structures were carried out using density functional theory (DFT), and it was found that linear N_3^- formed intermolecular hydrogen bonds with N-H in the host molecule in a horizontal manner. 1H NMR spectroscopy and rotational dynamics measurements

show that the rotational time constant of N_3^- can be used to qualitatively characterize the number of hydrogen bonds formed between the anion and the calix[4]pyrrole host molecule. When Na^+ is present in solution, due to its relatively strong electrostatic interaction with N_3^- , the molecular conformation of calix[4]pyrrole does not necessarily change from 1,3-alternate to cone conformation to bind to N_3^- .

This is the first experimental demonstration of the ultrafast dynamics of the recognition of N_3^- by the calix[4]pyrrole host molecule in solution with ultrafast IR spectroscopy. It is expected that the current study will provide useful kinetic data and research ideas from the perspective view of dynamics into the microscopic mechanism of anion recognition by macrocyclic host molecules.

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Full Text Link: <https://pubs.acs.org/doi/10.1021/acs.jpcclett.1c03962>

Strong Dynamic Interfacial Adhesion by Polymeric Ionic Liquids under Extreme Conditions

Xinling Deng,[#] Jiaqi Tang,[#] Wang Guan,[#] Wenhe Jiang, Miaomiao Zhang, Yongkang Liu, Hsin-Lang Chen, Cheng-Lung Chen, Yuangang Li, Kaiqiang Liu,^{*} and Yu Fang

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极端条件下的界面粘合新进展

针对常规粘合剂在有机溶剂中易于溶胀或溶解、在超低温下易于龟裂或变形等界面粘合失效问题，本文采用了分子间超分子作用平衡控制策略，设计制备了三种线性聚离子液体粘合剂，成功实现了其在多种表界面的高效动态粘合、优良的有机溶剂与超低温耐受性。为了进一步阐明粘合剂分子结构对其界面粘合性能的影响，本文采用了分子动力学模拟与量化计算，深入剖析了界面粘合\去粘合过程中聚离子液体及其自由离子的分离与迁移机制，明确了决定界面粘合性能聚离子液体的分子结构主次因素，为后续极端条件下界面粘合与应力敏感材料的创制奠定基础。

研究亮点:

(1) 该类粘合剂具有广泛的界面适应性，且界面粘合性能

能可高达 5.0 MPa，用于秋千吊绳连接点（不锈钢，粘结面积 2 cm²）能承载至少 86 kg 的重量；

(2) 该类粘合剂在 9 种常见有机溶剂中浸泡 100 天或在液氮里浸泡 4 天后，其界面粘合性能均不衰减；

(3) 该类粘合剂在温度从 40 °C 降低至 -130 °C 过程中始终

未见相分离，其损耗因子与复合粘度均随冷热循环呈可逆变化规律；

(4) 该类粘合剂可作为油箱漏油或天然气管道泄露的应急补救粘合剂。

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通讯作者：陕西师范大学刘凯强研究员
全文链接：<https://doi.org/10.1021/acsnano.1c10946>

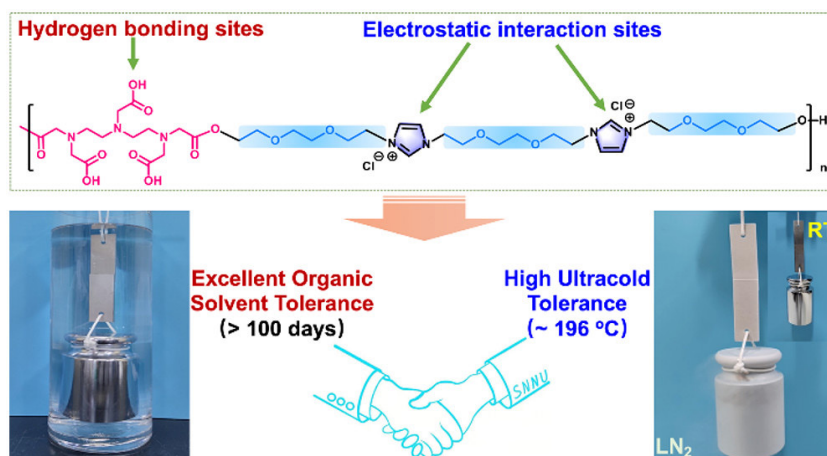


图 1. 分子结构与界面粘合的溶剂与低温耐受性

Figure 1. Molecular structure and interfacial adhesion solvents and low temperature tolerance.

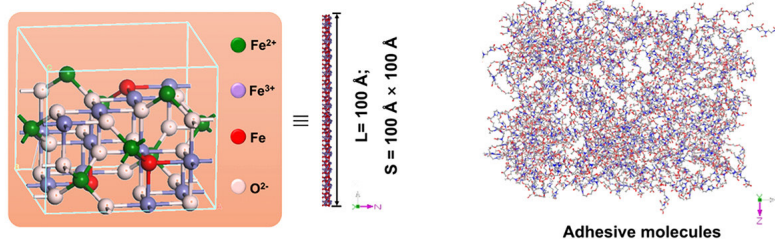
To order to meet with challenges and difficulties for interfacial adhesion, swelling or dissolution in organic solvents as well as cracking or deformation under ultra-low temperature environment, we have developed three linear polymeric ionic liquids by using intermolecular force-control strategy. As a result, these ionic liquids exhibited strong dynamic adhesion at various interfaces no matter where they were performed in organic solvents or under ultracold temperature. To understand the adhesion mechanism, molecular dynamics simulation and quantitative calculation were used to reveal the movement of polymeric ionic liquids along with free ions during the interfacial adhesion/debonding processes. Meanwhile, the key factors of molecular structures of polymeric ionic liquids determining their interfacial adhesion performances were identified. All the findings in this work have provided an efficient approach to develop new-generation high-performance adhesives or strain-sensitive materials under extreme conditions.

Research highlights:

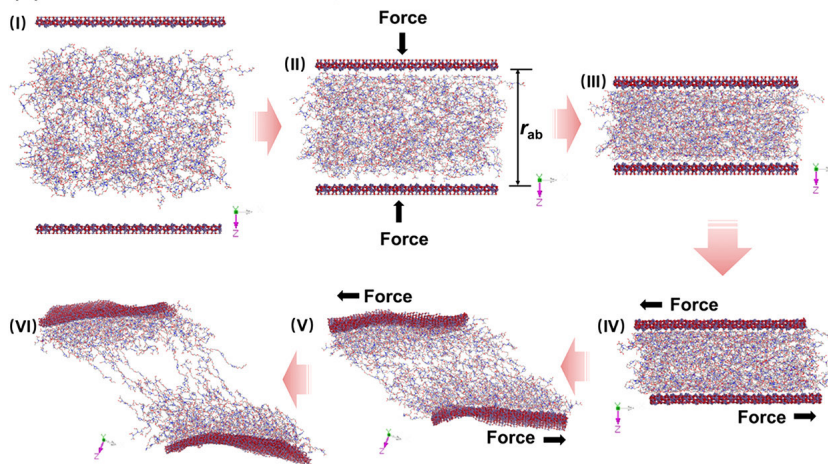
(1) The resulting adhesive exhibits excellent interface adaptability, along with an adhesion strength up to about 5.0 MPa, and it can carry a weight of at least 86 kg by hanging joint with a small bonding area of 2 cm²;

(2) The adhesion strength of the resulting adhesives could keep

(a) Interface and molecular model



(b) Interface adhesion & Lap shearing



(c) Charge movement during lap shearing



图 2. 界面粘结的分子动力学模拟和搭接剪切试验

Figure 2. Molecular dynamics simulation of the interfacial adhesion and the lap shear test.

very stable in nine common organic solvents for 100 days or liquid nitrogen for 4 days.

(3) No clear phase separation was found in the temperature cycle between 40 °C and -130 °C and the loss modulus and complex viscosity of the adhesive were fully reversible during the temperature changes;

(4) The developed adhesive in this work can be potentially used as

an emergency adhesive for dealing with leakage accidents of oil tank or natural gas pipeline.

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Full Text Link: <https://pubs.acs.org/doi/10.1021/acsnano.1c10946>

Vesicles Balance Osmotic Stress with Bending Energy That Can Be Released to Form Daughter Vesicles

Xiaoyan Liu, Joakim Stenhammar, Håkan Wennerström, and Emma Sparr*

Cite This: *J. Phys. Chem. Lett.* 2022, 13, 498–507

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单组份囊泡对渗透压的响应及其理论研究

本工作结合实验和理论计算研究了单组份囊泡对渗透压的响应。我们致力于简化实验体系设计，降低研究对象的复杂性，制备了单组份组成的囊泡。利用激光共聚焦显微镜观察了此囊泡在正渗透压以及可逆其渗透压的响应。该研究揭示了囊泡双层膜储藏的弯曲能量可以平衡膜内外渗透压，当可逆其渗透压时膜储藏的弯曲能量会被释放驱动膜分裂和融合过程，最终在囊泡内部形成小囊泡。此工作为物理化学、生物物理学和生物学的结合起到了桥梁作用，推进了细胞分裂和融合过程机理的探索。

研究亮点:

(1) 即使在囊泡内部在纯水(无溶质)条件下,单组份囊泡双层膜储藏的弯曲能量可以平衡膜内外渗透压。

(2) 在正向渗透压差大于0.15 大气压时,囊泡会从球形变

成扁长型(Figure 1e,h)。

(3) 当从正向渗透压可逆至膜内外无渗透压差时膜储藏的弯曲能量会被释放进而在囊泡内部形成小囊泡(Figure 1f)。

(4) 如果囊泡膜上有纳米尺寸的孔道形成(蜂毒肽可以在膜上形成纳米孔道),则从正向渗透

压可逆至膜内外无渗透压差时囊泡内部不会形成小囊泡(Figure 1i),主要是因为水很快从膜外进入膜内小囊泡无法在短时间内形成。

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全文链接: <https://doi.org/10.1021/acs.jpcclett.1c03369>

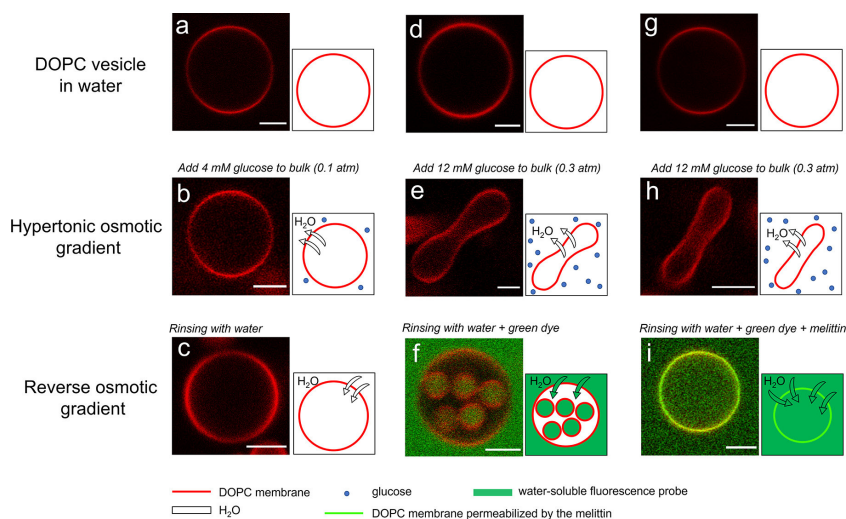


图 1. 模拟细胞膜对渗透压, 可逆渗透压以及对蜂毒肽的响应。
Figure 1. 2D CLSM images of DOPC vesicles in pure water (a,d,g), exposed to osmotic gradients of 0.1 atm (b) or 0.3 atm (e,h) and subsequently rinsed by water (c,f) or water with 1 μ M melittin (i). For panels f and i, a water-soluble green fluorophore Alexa488 was added to the rinsing water. The temperature was kept constant at 20 $^{\circ}$ C, and the scale bars represent 5 μ m.

Much of the material transport within and between cells involves lipid vesicles. The key processes are lipid membrane fusion and fission. These processes play a central functional role in living systems and are controlled by complex mechanisms evolved through natural selection. In the cellular environment, endocytosis and exocytosis can be triggered in a number of ways depending on the local conditions. One route toward a molecular understanding of exocytosis and endocytosis is to study the fundamental aspects of the phenomenon and to clarify obstacles that must be overcome in specific physiological processes in order to accomplish a specific event. One key open question here is the role of different membrane-binding proteins in promoting fusion or fission relevant for living systems. Another important discussion concerns the fusion or fission of essentially pure lipid vesicles, where no such proteins are present. The membrane remodeling processes associated with membrane fusion, fission, and tubulation all involve the formation of highly curved structures and may therefore be facilitated by an asymmetric or patchy organization of lipids and proteins in the membrane. Another physiologically relevant aspect affecting the properties of cellular membranes is the regulation of osmotic pressure.

In the present paper, we study the response of single- component giant unilamellar vesicles, GUVs,

to changes in osmotic conditions. We follow the osmotically induced shape changes of the GUVs and show how an increase in the external osmotic pressure can induce a global deformation of pure lipid vesicles. Upon reversing the osmotic gradient, we furthermore demonstrate a spontaneous fission process leading to the formation of daughter vesicles inside the primary mother vesicle. These results demonstrate a clear coupling between osmotic changes and vesicle fission, and an energetic analysis of the fission process. In this study, we have made an

effort to reduce the complexity of the system as much as possible by studying vesicles composed of a single (or, in some cases, two) lipid components, diffusing freely in a bulk solution containing no additional solutes such as buffer or electrolytes. This simplicity enables theoretical analysis of the observed phenomena and allows us to shed light on the energetics of vesicle deformation and fission.

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 Full Text Link: <https://doi.org/10.1021/acs.jpcclett.1c03369>

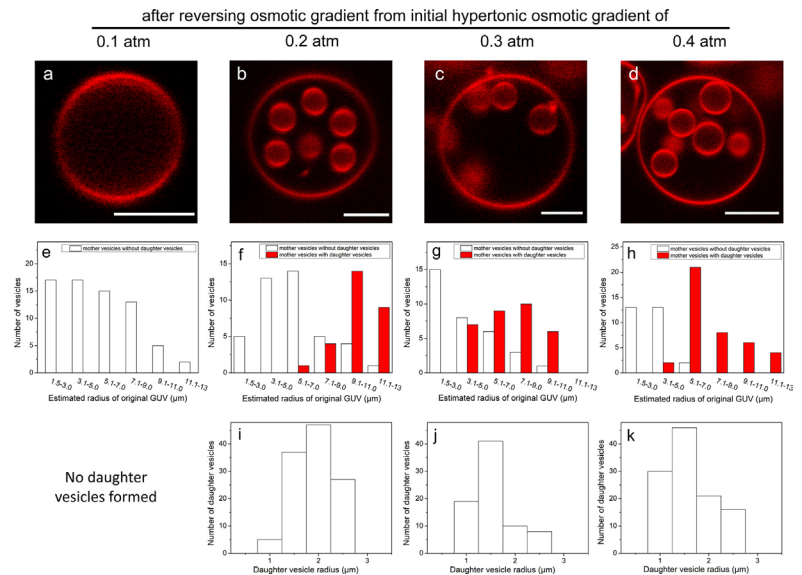


图 2. 拟细胞膜在可逆渗透压下产生小囊泡。对小囊泡尺寸分布以及其对应原始模拟细胞膜的膜面积分析。
 Figure 2. 2D CLSM images of GUVs composed of DOPC (20 °C) after reversing the osmotic gradient from initial values of $\pi = 0.1$ atm (a), $\pi = 0.2$ atm (b), $\pi = 0.3$ atm (c), and $\pi = 0.4$ atm (d). The scale bars represent 5 μm . When the gradient is reversed from 0.1 atm, no daughter vesicles are observed. For the higher osmotic gradients, daughter vesicles are formed inside the larger vesicles. Panels (e–g) show the occurrence of daughter vesicles for mother vesicles of different original size, here represented by the radius of the original spherical vesicles, as recalculated from the estimated total membrane area including both mother and daughter vesicles. Panels (i–k) show histograms of the daughter vesicle radius under conditions corresponding to panels (b–d). For each condition, 35 mother vesicles containing daughter vesicles were analyzed.

Self-Assembly of Amphiphilic BODIPY Derivatives on Micropatterned Ionic Liquid Surfaces for Fluorescent Films with Excellent Stability and Sensing Performance

Hairui Lei,[§] Huimin Han,[§] Gang Wang, Somnath Mukherjee, Hongtao Bian, Jing Liu,* Chuan Zhao, and Yu Fang

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两亲性 BODIPY 衍生物的微液珠表面组装 构筑高性能荧光薄膜

薄膜基荧光传感因其具备灵敏度高、响应速度快、可设计性强等优势已逐步发展成为继离子迁移谱之后业界公认的一项最具发展潜力的微痕量物质探测技术。然而，业已报道的多数荧光薄膜均为固态薄膜，气-固界面上的荧光传感单元易发生光降

解，而且待分析物在薄膜中的传质过程严重影响了薄膜的传感性能。为此，本工作首次提出利用两亲性荧光分子的表面富集特性构筑微阵列气-液界面单分子层荧光薄膜，该荧光薄膜不仅表现出了良好的光化学稳定性，同时对神经毒气模拟物 DCP 表现

出了优异的传感性能。该工作为丰富荧光薄膜设计思路、提升荧光薄膜传感性能、拓宽荧光薄膜实际应用奠定了一定基础。

研究亮点：

(1) 首次制备了气-液界面单分子层荧光薄膜，克服了传统固态荧光薄膜中荧光传感单元

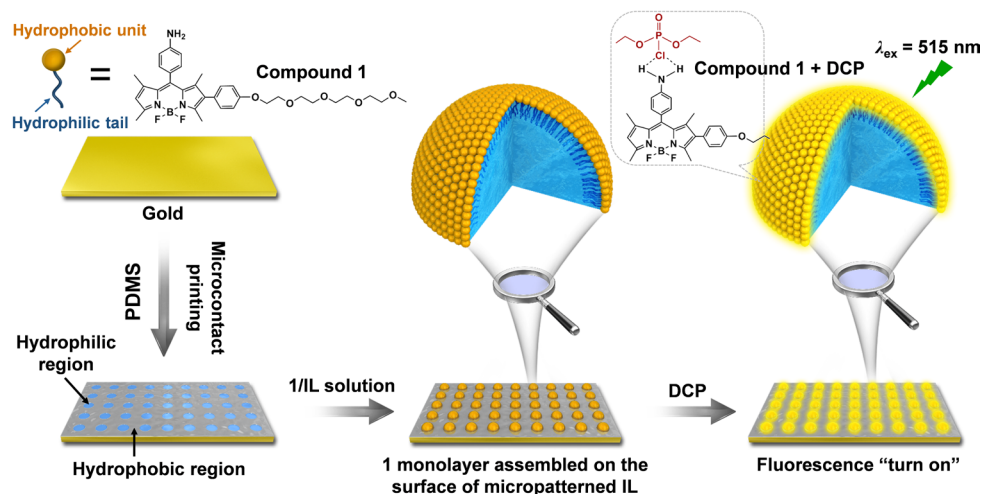


图 1. 拟微阵列液滴表面的单分子层荧光传感薄膜的制备及其对有机磷 DCP 的传感示意图。Figure 1. Schematic representation of the fabrication and DCP sensing of the fluorescent monolayer film assembled on the surface of the micropatterned IL. Solid substrate: gold-coated silicon substrate.

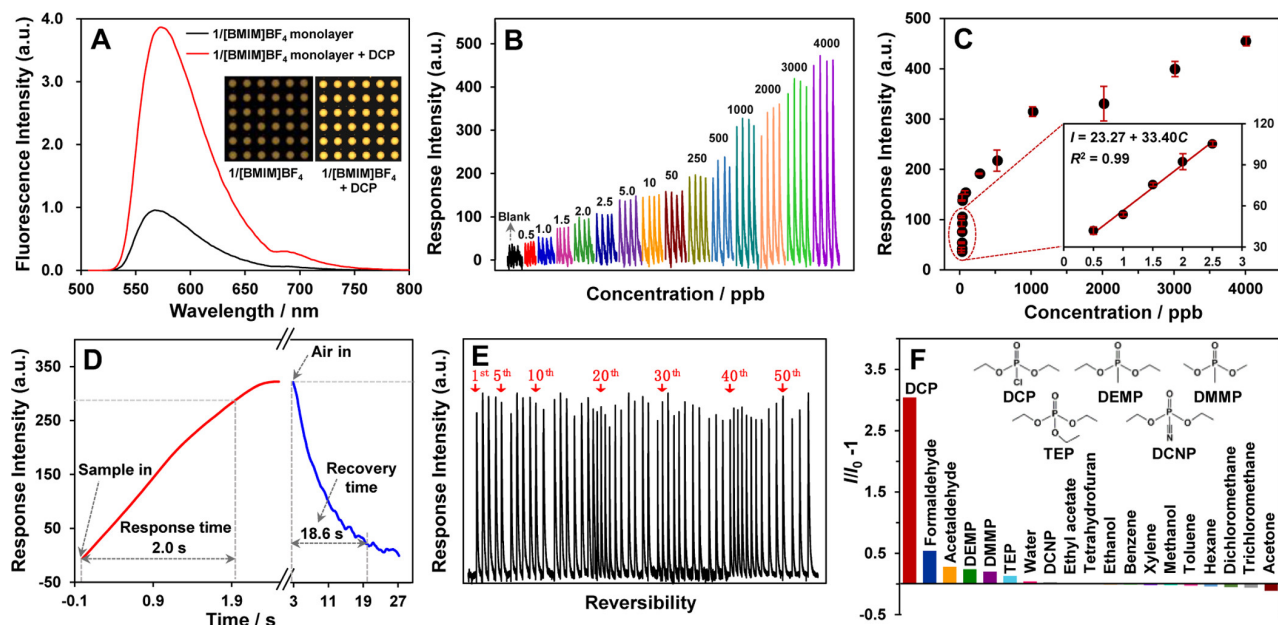


图 2. 微阵列液滴表面的单分子层荧光传感薄膜对有机磷 DCP 的传感性能。
Figure 2. Sensing performance of the 1/[BMIM]BF₄ monolayer to DCP vapor.

易光降解等缺陷，气-液界面薄膜表现出了优异的光化学稳定性；

(2) 荧光分子组装在阵列化的微液珠表面，避免了待分析物的膜内传质过程，大幅提升了荧光薄膜的传感性能，其对 DCP 分子的响应时间仅为 2 s，检出限为 226 ppt，此浓度低于威胁人体健康浓度的 30 倍，而且薄膜循环使用 50 次以上未发生传感性能衰减。

第一作者：陕西师范大学博士毕业生、浙江大学博士后雷海瑞、陕西师范大学硕士毕业生韩慧敏

通讯作者：陕西师范大学刘静教授

全文链接：<https://pubs.acs.org/doi/10.1021/acsami.2c01417>

Fluorescent film has been widely recognized as one of the most powerful tools for trace

analyte detection for the ultra-sensitivity, rapid response speed and designability. However, their uses have been limited due to the poor photochemical stability of the fluorophores at gas-solid interface and the inefficient film mass transfer. Herein, a novel fluorescent film was developed through self-assembly of the amphiphilic BODIPY derivative on micropatterned ionic liquid surface. Unlike solid-state films, the obtained monolayer films exhibit excellent photochemical stability, similar to that of the solution.

Moreover, the interfacial assembly of amphiphilic fluorophores can avoid gas diffusion inside the microdroplet, significantly improving the sensing performance. 1/[BMIM]BF₄ monolayer exhibits high sensitivity, high selectivity

and fast response speed to detect diethylchlorophosphate (DCP) vapor. The detection limit was 226 ppt, with a response time to DCP of 2.0 s. Importantly, 1/[BMIM]BF₄ monolayer can be reused for at least 50 cycles with no obvious signal fading.

This study is expected to benefit the development of new strategies for designing fluorescent sensing films and lay a solid foundation for the fabrication of multifunctional sensing devices with excellent photochemical stability and sensing performance.

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Full Text Link: <https://pubs.acs.org/doi/10.1021/acsami.2c01417>

薄膜荧光传感器和可控缓释材料

Thin Film Fluorescence Sensor and Controllable Sustained-release Material

陕西师范大学应用表面与胶体化学教育部重点实验室房喻院士领衔的光子鼻与分子材料团队长期从事薄膜荧光传感和凝胶化学研究工作，在成功研制已经产业化的爆炸物薄膜荧光传感器、毒品薄膜荧光传感器和相关探测装备的基础上，最近又研制了甲醛、二氧化氯和苯系物薄膜荧光传感器和相应的便携式或概念性探测装备。与此同时，团队立足胶体与界面化学研究优势，研制了一类透气性缓释材料，可以实现对香氛、精油、药物、消毒杀菌剂等挥发性物质的控制释放，具有巨大而又多样化的市场应用前景。

The Ministry of Education Key Laboratory of Applied Surface and Colloid Chemistry at Shaanxi Normal University, led by CAS academician Fang Yu and long engaged in the research of film-based fluorescence sensors and gel chemistry, has recently developed the film-based fluorescence sensors for formaldehyde, ClO₂ and BTEX and corresponding portable or conceptual sensing devices, on the basis of already commercialized explosive film-based fluorescence sensor, narcotics film-based fluorescence sensor and corresponding sensing devices. Meanwhile, the Fang group, taking advantage of its research in colloid and interface chemistry, has developed a breathable and impermeable material, which can realize sustained-release of volatile substances such as fragrance, essential oil, medicine and disinfectant, and has huge and diversified market prospects.

手持式甲醛检测仪

A Handheld Formaldehyde Detector

陕西师范大学化学化工学院光子鼻与分子材料团队基于薄膜荧光传感技术，研制了一种手持式甲醛检测仪，专门用于密闭空间内甲醛浓度的定量检测。该检测仪采用薄膜荧光技术，无放射性，无需预热，操作简便，检测快速。

规格参数：（1）检测对象：密闭空间空气中的甲醛；（2）采样方式：泵吸，采样速度可调；（3）检测区间：0~0.20 mg/m³；（4）检出限≤ 0.01 mg/m³；（5）响应时间≤ 5 s；（6）恢复时间≤ 20 s；（7）工作温度：0~40 ℃；（8）供电方式：可充电锂电池；

（9）重量：~400 g；（10）外形尺寸：200 mm × 6 mm × 40 mm；（11）连续工作时间 > 8 h。

技术特点：（1）体积小、重量轻、功耗低；（2）传感性能优越（响应速度快、灵敏度高、可逆性好），一键检测；（3）高清彩色液晶显示屏；（4）实时



监控测试环境的温湿度；（5）配上上位机软件，USB 接口连接电脑可实时传输检测数据；（6）声光报警；（7）气体浓度单位可选：ppm, mg/m³。

应用前景：该检测器可用于（1）室内装修，（2）家具环保，（3）造纸、制药、家具、涂料，（4）相关生产企业等环境中甲醛浓度的检测。

Using film-based fluorescence sensing technology, the Photonic Nose and Molecular Materials Group at Shaanxi Normal University's School of Chemistry and Chemical Engineering have develop a handheld formaldehyde detector specializing in the quantitative detection of formaldehyde concentration in confined space. The radiation-free fast response detector is easy to operate and does not need warming up.

Specifications: (1) Detection Object: formaldehyde in confined

space; (2) Sampling Mode: Pump suction, at variable speed; (3) Detection Range: 0 ~ 0.20 mg/m³; (4) Detection Limit: ≤ 0.01 mg/m³; (5) Response Time: ≤ 5 s; (6) Delay Time: ≤ 20 s; (7) Operation Temperature: 0~40 °C; (8) Power Supply: Rechargeable lithium battery; (9) Weight: 400 g; (10) Measurement: 200 mm x 6 mm x 40 mm; (11) Continuous Working Time: > 8 h.

Technical Features: (1) Small volume, light weight, low power consumption; (2) Excellent performance (fast, sensitive, reversible); (3) LCD display; (4) Real-time monitoring of temperature and humidity; (5) capable of transmitting real-time testing data via USB port; (6) sound and light alarm; (7) gas concentration unit selectable: ppm, mg/m³.

Application Scenarios: (1) interior decoration, (2) paper-making, pharmaceutical, and, (3) other related industrial environment.

二氧化氯是一种红黄色有强烈刺激性臭味的气体，在光照或热水环境中易分解，极易溶于水而不与水反应，制备的水溶液具有杀菌、漂白、除臭、消毒、保鲜等功能。传统 ClO₂ 的检测方法包括五步碘量法、紫外-可见分光光度法、色谱法等。但这些方法操作复杂、耗时且仪器要求高，不适合原位现场实时检测。为此，陕西师范大学化学化工学院光子鼻与分子材料团队发展了二氧化氯薄膜荧光传感技术，实现了对气相 ClO₂ 的直接和对水体 ClO₂ 的非接触式定量检测。

规格参数：（1）检测对象：气相和水溶液中 ClO₂ 的浓度；（2）检测技术：薄膜荧光传感；（3）采样方式：泵吸采样，流量大小可调；（4）检测区间：水体 0~5000 mg/L；（5）检出限 < 5mg/L；（6）响应时间 ≤ 1 s；（7）恢复时间 < 8 s；（8）工作温度：0~40 °C。

技术特点：（1）体积小、功耗低；（2）性能优越（响应速度快、灵敏度高、选择性好）；（3）实时显示测量结果；（4）可实现原位在线快速监测。

应用场景：实时在线监测（1）水体 ClO₂ 消毒，（2）厨房用具、食品机械设备消毒，（3）医疗器械消毒，（4）水产养殖、畜禽养殖消毒，以及（5）食品保

二氧化氯薄膜荧光传感器

A Thin Film Fluorescence Sensor for ClO₂

鲜等工业操作过程中 ClO₂ 浓度是否足够，是否超标。

Chlorine dioxide (ClO₂), a reddish yellow gas with strong pungent odor, easily decomposes in light or hot water, is highly resolvable in water but does not react with water, and its water solution is widely used for sterilization, bleaching, deodorization, disinfection and food preservation. Traditional detection of ClO₂ includes five-step iodometry, ultraviolet-visible spectrophotometry, and chromatography, which operation is complicated, time-consuming and has a high requirement for testing instrument, not suitable for in situ real-time detection. Therefore, the Photonic Nose and Molecular Materials Group at Shaanxi Normal University's School of Chemistry and Chemical Engineering have developed a film-based fluorescence sensing technology and realized the direct quantitative testing for gas-phase ClO₂ in air and the non-contact quantitative testing for ClO₂ in water.

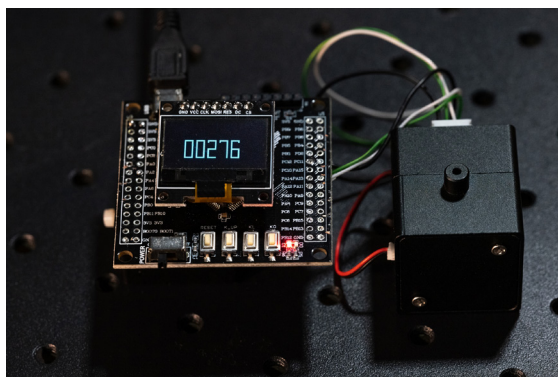
Specifications:

(1) Detection Object: concentration of ClO₂ in air and water;

(2) Detection Technique: film-based fluorescence sensing; (3) Sampling Mode: Pump suction, at variable flow size; (4) Detection Range: 0~5000 mg/L for water solution; (5) Detection Limit: < 5 mg/L; (6) Response Time: ≤ 5 s; (7) Delay Time: ≤ 1 s; (8) Recovery Time: < 8 s; (9) Operation Temperature: 0~40 °C .

Technical Features: (1) Small volume, low power consumption; (2) Superb sensor performance (fast response speed, high sensitivity, good selectivity); (3) Real-time in situ online rapid monitoring.

Application Scenarios: Real time online monitoring of (1) disinfection of kitchen utensils and food machinery, (2) disinfection of medical apparatus and instruments, (3) disinfection in aquaculture and livestock and poultry breeding, and (4) ClO₂ concentration in the operational process of food preservation.



苯系物是近年来备受关注的强致癌致畸性物质，主要包括苯、甲苯、乙基苯、二甲苯（包括邻、间、对）（BTEX）等。陕西师范大学化学化工学院光子鼻与分子材料团队发展了一种 BTEX 薄膜荧光传感器。可以实现对大气中 BTEX 的超灵敏和区分检测。

规格参数：（1）检测对象：敞开体系或密闭空间空气中的微量苯、甲苯、乙苯、邻二甲苯、间二甲苯和对二甲苯；（2）采样方式：泵吸式采样，流量大小可调；（3）检测区间：苯（0~140 ppm），甲苯（0~50 ppm），乙苯（0~10 ppm），邻二甲苯（0~1 ppm），间二甲苯（0~10 ppm），对二甲苯（0~6 ppm）；（4）检出限：苯 ≤ 3.25 ppm，甲苯 ≤ 2.7 ppm，乙苯 ≤ 1.9 ppm，邻二甲苯 ≤ 0.2 ppm，间二甲苯 ≤ 0.4 ppm，对二甲苯 ≤ 0.4 ppm；（5）响应时间 ≤ 3 s；（6）恢复时间：苯 14 s，甲苯 30 s，乙苯 60 s，邻二甲苯 80 s，间二甲苯 90 s，对二甲苯 120 s；（7）线性误差 ≤ ± 1 %；（8）工作温度：0~40 °C。

技术特点：（1）灵敏度高，选择性好，测试过程完全可逆；（2）检测数据可经由 USB 接口实时导入电脑；（3）利用动态响应信息可以实现对部分 BTEX 的区分检测；（4）原位在线检测；（5）空气作为载气，环境适应

苯系物薄膜荧光传感器

A Film Fluorescence Sensor for BTEX

性好。

应用场景：（1）室内空气；（2）生产车间；（3）有关公共场所。

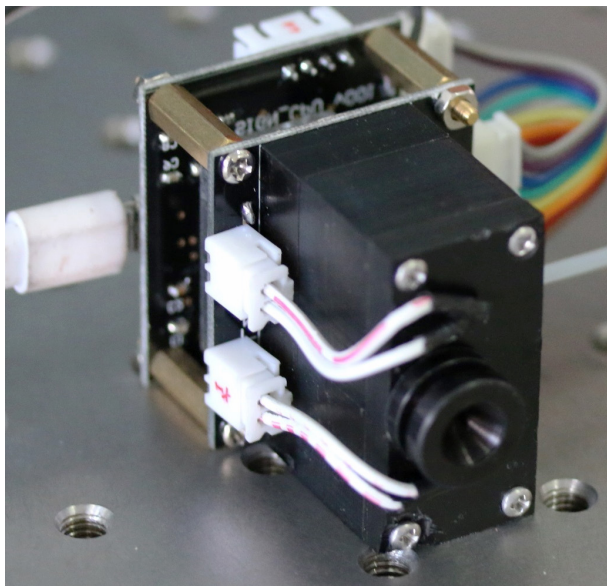
Benzenes or BTEX, including benzene, methylbenzene, ethylbenzene and xylene (including o-xylene, m-xylene and p-xylene), are strong carcinogenic teratogenic substances that have begun to concern people in recent years. The Photonic Nose and Molecular Materials Group at Shaanxi Normal University's School of Chemistry and Chemical Engineering have developed a film-based fluorescence sensor for BTEX, which can realize ultrasensitive and differentiated detection of BTEX in the air.

Specifications: (1) Detection Object: Benzene, methylbenzene, ethylbenzene, o-xylene, m-xylene and p-xylene in the air of open or closed space; (2) Sampling Mode: Pump suction, at variable flow size; (3) Detection Range: Benzene (0~140 ppm), methylbenzene (0~50 ppm),

ethylbenzene (0~10 ppm), o-xylene (0~1 ppm), m-xylene (0~10 ppm), p-xylene (0~6 ppm); (5) Response Time: ≤ 3 s; (6) Recovery Time: Benzene 14 s, methylbenzene 30 s, ethylbenzene 60 s, o-xylene 80 s, m-xylene 90 s, p-xylene 120 s; (7) Linear Error: $\leq \pm 1\%$; (8) Operation Temperature: 0~40 °C .

Technical Features: (1) High sensitivity, good selectivity, reversible testing process; (2) Test data can be input into computer in real-time via a USB port; (3) Differentiated detection of some BTEX can be realized with dynamic response information; (4) In situ online testing; (5) good adaptability to environment.

Application Scenarios: (1) indoor air; (2) workshops; (3) public places.



陕西师范大学化学化工学院光子鼻与分子材料团队，立足胶体与界面化学多年研究工作积累，研制了一类微纳通孔材料，用于香氛、精油、药理性物质、保鲜剂以及消毒杀菌剂等活性物质的控制释放，表现出一系列独特的优点。

性能指标：（1）材料密度可在 0.10~0.70 g/cm³ 之间大范围调控；（2）压缩强度 1~50 MPa；（3）多级孔结构，微米孔尺寸 1 ~ 50 μm，孔喉尺寸 10 nm ~ 2 μm；（4）耐介质、耐酸碱盐性能突出；（5）材料整体透气不透水；（6）热分解温度 >300 °C；（7）隔热降噪，导热系数 < 0.093 W/(m·K)；（8）加工性能优异；（9）生产工艺兼容性好，易于引入其它组分，得到复合材料。

技术特点：基于该透气不透水材料制作的缓释产品，至少具有以下几个特点：（1）产品外观及设计多样；（2）内部活性物质发挥作用效果稳定、时间长、利用率高；（3）安全性高，可避免环境光、热等因素干扰。

实践意义：在实践中，透气不透水材料极其稀少，将其用于高附加值高性能功能物质缓释时，可以解决市售不同缓释产品的诸多问题。与此同时，还可大幅度拓展产品创新空间，丰富产品类型，提高产品性价比。

透气不透水性缓释材料

A Breathable and Impermeable Sustained-release Material

Based on their long-time research findings in colloid and surface chemistry, the Photonic Nose and Molecular Materials Group at Shaanxi Normal University's School of Chemistry and Chemical Engineering have developed a micro-nano pored material, which can be used in the sustained release of active substances such as fragrances, essential oils, pharmacologic substances, preservatives and disinfectants, exhibiting a series of advantages.

Specifications: (1) Material density can be regulated within the wide range of 0.10~0.70 g/cm³; (2) Compressive strength is 1~50 MPa; (3) Multiple pore structure, with 1 ~ 50 μm micrometer pores and 10 nm ~ 2 μm pore-throats; (4) Highly resistant to medium, acid, alkali and salt; (5) Breathable and impermeable; (6) Thermal decomposition temperature > 300 °C; (7) Heat insulating and noise reducing, with thermal conductivity < 0.093 W/(m•K); (8) Excellent processability; (9) Good compatibility in production process, easy to introduce other components to obtain composite materials.

Technical Features: The sustained-release products made of this breathable and impermeable material have at least the following

features: (1) Versatile in product appearance and design; (2) Stable and long-time performance and high utilization rate of the active substances within; (3) higher safety, free from the interference of ambient light and heat, etc.

Pragmatic Significance: Breathable and impermeable materials are scarce. If this material is used in the sustained release

of high added value and high performance functional substances, many problems with the sustained-release products currently available on market can be solved. In the meantime, using this material can substantially expand the space for product innovation, enrich product types and improve the cost performance of products.



图1 概念性缓释和雕刻产品
Figure 1 Conceptual sustained-release and carved products



图2 概念性染色 / 荧光样件
Figure 2 Conceptual dyed/fluorescent samples

西安光机所马彩文所长一行来访

Meeting held with XIOPM visitors to discuss cooperation

3月28日，中国科学院西安光学精密机械研究所所长马彩文研究员、基础科研处处长王博研究员、阿秒中心常务副主任付玉喜研究员以及王超副研究员一行四人来团队访问交流。

团队负责人房喻院士介绍了自1998年以来团队的科研历程，概括了团队在基础研究到产业转化方面取得的重要成绩，包括从荧光传感到高端爆炸物、毒品检测仪的诞生，从试管实验的凝胶化学到凝胶推进剂、凝胶云爆弹、低密度高强度材料等领域的重要拓展。

马彩文研究员介绍了西安光机所的基本情况，希望能在科研中与团队有实质性合作。付玉喜

研究员详细介绍了阿秒光源的重大意义、发展趋势以及阿秒中心的建设情况。



On March 28, four guests from Chinese Academy of Sciences' Xi'an Institute of Optics and Precision Mechanics visited the Photonic Nose and Molecular Materials Group.

The XIOPM guests are Mr. Ma Caiwen, research fellow and institute director, Mr. Wang Bo, research fellow and head of basic research division, Mr. Fu Yuxi,

research fellow and executive vice director of the institute's Attosecond Center, and associate research fellow Mr. Wang Chao.

Fang Yu briefed the guests about the R&D history of the group since 1998, summarized their major achievements in basic research and industrialization, including fluorescent sensing, high-end explosives detector, narcotics detector, gel propellants, gelled fuel-air-explosives and low-density high-strength materials.

Ma Caiwen briefed about Xi'an Institute of Optics and Precision Mechanics and hoped to the two parties could engage in substantial cooperation. Fu Yuxi talked about the significance and development of attosecond illuminant, and the construction of the Attosecond Center.



疫情怡事——贴近泥土的感悟

My reflections during Covid Pandemic: Staying close to the soil

要说真正贴近泥土睡觉的日子，是少年时代牧牛牧羊的时候，每每看着满山遍野的牛羊，要么玩味武侠小说中的天马行空，要么完成老师布置的作业，要么就点燃一支旱烟放在头边用以驱蚊虫，便于安然听风入梦，现在听起来似乎就是唐诗宋词中描绘的田园生活，令人神往；但要说惯于以地为床的人，多半是那些在外作业的农民工，他们累了困了往往是席地而卧，从他们周身上散发出的汗水与泥土的味道，包含着一种艰辛生活的酸涩而浑浊……

要说这几年最令人困扰的事情就莫过于百年难遇的新冠疫情，它如一场突如其来的飓风席卷了整个世界，古都长安也不例外。人们安稳的生活被无情打乱，隔离、核酸检测、疫苗接种、病痛与死亡等一度成为人们生活的主旋律，那些街头巷尾的大小店面也因此纷纷关门或倒闭，就连那些想顺顺利利谈场恋爱的人来说去寻得整段时间似乎也变得十分困难了，自然很难看到有机会席地而卧的人们……

相比而言，能在高等学府里工作学习的人是何等的幸福！我们不用像那些风雪无阻、坚守岗位的疫情防护人员奔走救护，不用像那些自谋出路的人们苦于生计而心力交瘁……不用像那些主要靠游走四方赚钱养家的人无计可施……我们至少可以毫无顾虑、毫无障碍地去思考一些或深或浅的科学问题。

算是一种新的生活体验，在疫情隔离期间，与团队成员刘忠山老师不约而同地先后移居于办公室，吃在学生食堂。此时此刻，总不由自主地回想起自己曾席地而卧的场景。如今折叠床的高度足以克服地板的潮湿与清凉，但也发现自己已经委实丢掉了农民特有的坚韧，硬板床与自己的身体硬碰硬好像真有点不太默契，全身酸爽的时候才由衷羡慕那些匀称肥胖的身材，仔细一想这不就是材料界面的适应性问题嘛，铺上床垫自然有助于酣然入梦。半夜醒来，窗外的风像是溶解了春的味道，一种贴近泥土真实的味道，我知道这就是大自然的律动与召唤；贴在背景墙上的分子

结构好像一直在嘲讽自己1997年高考化学有关富勒烯分子结构“解析”的失误，这也许就是命中注定的劫数，自己始终没有绕过这个挡在心口的碳球，成了这些年浅显研究探索自圆其说的一个理由。

算是一种新的生活体验，在办公室工作休息做梦变得异常稀少，工作效率也是居家无法相比的。幸得学校科技处基金负责人大力支持与课题组一名博士生的善意提醒，连夜修正了基金申请书中的瑕疵与惯用术语，也把近期接收的文章号及时写到了基金申请书里，如果居家办公估计这个机会多半是丢掉了。此外，在食堂与办公室往来区间也是值得留住的美好记忆：那雅致而朴素的昆明湖、那春色盎然的不高山、那嘎嘎乱叫张扬十足的鸭群，那火红而鲜活的日出、那诗意不断的夕阳……还有那些身着红马甲维持排队买饭的志愿者。这一切路遇的风景看似平常，但在这个时段里却显得尤为珍贵与迷人！此时此刻，硬碰硬的酸爽似乎饶有趣味，成了一种蕴含着科学原

理真实的生命感受。然而这一切统统属于小家碧玉型的自娱自乐，与许多以地为床的人们相比，我们的经历简直不值一提，这只是科研生涯中回忆过往的一次小小的体验罢了！比起那些心系家国的大义者而言，这又何其渺小。

言语自此，已近尾声，没有精辟的总结，只有流水式的感慨：人生在世，若想活的通透何其艰难，不如活的简单！试看这连绵不断的疫情、猝不及防的空难足以告诉我们要珍惜现在的拥有，学会从阴霾中捕捉住美丽，从风雨中分辨出乐音，从无望中开掘出希望，从成功中孕育突破，从不平中积淀安宁……真心真意，认认真真地活好每一天，对得起天地，心存感恩而毅然前行！

要说真正贴近泥土睡觉的日子，若有机会还是要亲身去感受的，如果你愿意，我们一同前往！

刘凯强 记于 2022 年 3 月 28 日

It was well back when I was a boy herding cattle and sheep that I actually slept so close to the soil. I would fall asleep in the breeze as I watched cattle and sheep roaming on the hillside, while fantasizing over the plots in Kongfu novels, or doing my homework, or lighting up some tobacco to repel snakes and insects. This sounds like the much-desired pastoral life depicted in the Tang and Song poems now. However if we talk about people

who are used to sleeping on the ground, we usually refer to the migrant workers in cities, who would lie down to sleep wherever they are tired out after work --- the odour of sweat and soil speaking of the bitterness of hard life

The most disturbing thing in the past three years is the COVID-19 pandemic, which rampaged through the world like a tornado, and Xi'an is no exception. Ordinary life was interrupted --- quarantine, nucleic acid tests, vaccination, illness and death have become daily routine, and stores and restaurants are forced out of business. Even young lovers find it difficult to have a whole chunk of time for dating, let alone seeing someone sleeping on the ground

Comparatively speaking, I would say we are so fortunate working in a university. We do not have to risk our lives to fight COVID like those medical workers, or try to make a living like those self-employed when their business is forced to shut down, or to earn money to support the family from random jobs when the jobs are no longer there

At least we can have the luxury to ponder some scientific problems free from any inhibitions.

During the campus lockdown, Liu Zhongshan, another teacher of our group, and I chose to work and sleep in our office and eat at student canteen. This would immediately remind me of sleeping on the ground as a shepherd boy. Now the folding bed is high enough

above the ground to keep from humidity and coldness, but I found I had lost a farmer's endurance and resilience, as the hard bed appeared to be unfriendly with my body in this rough contact.

The proportionally built bodies of others became a heartfelt envy of me when I felt the soreness and aching all over my body. Isn't it a problem of adaptation of material interface --- lying on a mattress helps one to fall asleep. When I wake up in the middle of night, I found the wind outside my window had a smell of the spring being melt, a genuine smell so close to the soil, and I know this was the rhythm and summon of nature.

The molecular structure diagram on the wall seemed to be mocking my mistake in analyzing Fullerene molecular structure when I sat for the 1997 college entrance exam. This may be my predestined fate that this carbon sphere blocking my path has become a reason for me to carry on my research over these years.

I would consider this a new life experience. Dreaming became rare after I began to sleep in the office, and the work proficiency was much higher than working at home. Thanks to the support from the Department of Science and Technology colleague who was in charge of fund application and the kind reminder from a doctoral candidate of the group, I corrected some minor mistakes and misused terms, and added the recently published papers into the fund

application in the evening before the deadline. If I were working at home, this opportunity would have probably been lost.

Besides, the short distance back and forth between office and canteen was also something memorable: the simple yet elegant Kunming Pond, the greenish Bugaoshan Hill, the quacking ducks, the flaming sunrise, the poetic sunset and those red vest-clad volunteers maintaining orders of the queue at the canteen windows. These seemingly mundane scenes have become so valuable and charming during this special time. At this time, the sore caused by rough contact was

interesting enough to become an experience of life containing scientific principles. However, these are merely some self-entertaining reflections among the many events and experiences of my research career, unworthy of mentioning if compared with the experiences of those who had to sleep on the ground. How tiny and insignificant when it is compared with those who have devoted themselves heart and soul to the nation.

As I write to this point close to the end, I only have some humble reflection instead of incisive summary: It is so hard to live a wise and light-hearted life, so it is better to keep it simple. The intermittent

surges of COVID infections and the plane crash have taught us to cherish what we have now, and learn to capture silver lining from gloomy cloud, distinguish melodies from storm, excavate hope from despair, nourish breakthrough from success, and accumulate peace from unrest Live each single day honestly and earnestly, forge forward responsibly and gratefully.

If you ever have the chance, it is highly recommended that you live the experience of sleeping close to the soil by yourself. If you want to try, I will be glad to do it together with you.

Liu Kaiqiang, written on March 28, 2022

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