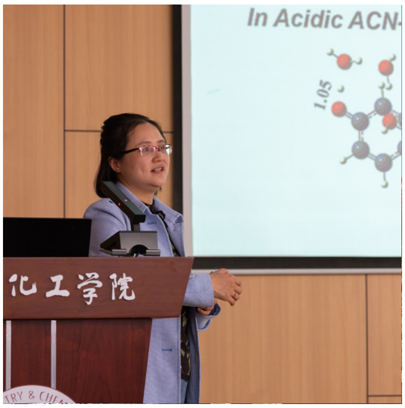
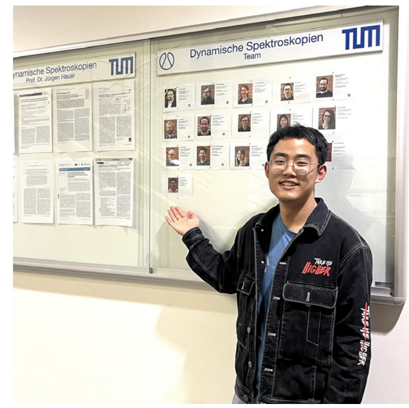
光子鼻与分子材料团队简报

Newsletter of Photonic Nose and Molecular Materials Group

4 / 2022




团队成果获陕西省 2021 年高教教学成果奖特等奖

Fang Group wins grand award in 2021 Shaanxi Higher Education Teaching Achievements

据 4 月 25 日陕西省教育厅高等教育处发布的公告，团队完成的成果《“素养为要——能力为本”物理化学专业五维一体研究生培养新模式》获陕西省 2021 年高教教学成果奖特等奖。

此项成果的主要完成人为房喻、丁立平、刘静、彭军霞、边红涛、刘凯强、刘太宏、彭浩南、苗荣。

该成果针对物理化学专业研究型人才培养中存在的“培养过程远离学科发展前沿，脱离国家建设需要的‘顶不及天、立不触地’，以及学生发展信心不够、动力不足、志向不高”等问题，立足物理化学专业实际，坚持“素养为要、能力为本”的研究生培养理念，建立了“以制度建设规范、以文化建设提升、以开放培养增强、以平台建设支撑、以团队协作保障”的多维度团队协作式物理化学专业研究型人才培养模式，较好地解决了研究生培养过程中存在的各种问题，研究生的培养质量得到了保障，青年导师的学术能力显著提高，团队服务国家和区域经济社会发展能力大大增强。

本届教学成果奖经学校推荐、评前公示、专家评审、厅务会审议等程序，共评出陕西省 2021 年普通本科高校高等教育教学成果奖 300 项，其中特等奖 51 项、一等奖 77 项、二等奖 172 项。

陕西省教育厅公告链接：

http://jyt.shaanxi.gov.cn/news/gsgg/202204/25/20446.htm

According to the notice released by the Higher Education Division of Shaanxi Provincial Department of Education on April 25, Fang Group won the grand award in 2021 Shaanxi Province Higher Education Teaching Achievements with its project “Literacy-focused and Capacity-based Five-dimensional Integrated Cultivation Mode for Physical Chemistry Graduate Student”.

The participants of this project are Fang Yu, Ding Liping, Liu Jing, Peng Junxia, Bian Hongtao,

Liu Kaiqiang, Liu Taihong, Peng Haonan and Miao Rong.

The project, based on the actual conditions of physical chemistry major and aiming at the problems in the cultivation of talents in physical chemistry such as “distanced from the frontiers of the discipline, divorced from the demand of China’s development” and the students’ lack of confidence, motivation and aspiration, develops a “Literacy-focused and Capacity-based” multidimensional team collaboration cultivation mode for research-oriented students in physical chemistry major, is featured by “regulation by institutional construction, improvement with cultural construction, enhancement by open-minded cultivation, support by platform construction, and safeguard by team collaboration”.

After the procedures of school recommendation, public notice, expert review and resolution by department meeting, 300 projects were commended by the 2021 Shaanxi Province Higher Education Teaching Achievements Award, including 51 grand prizes, 77 first prizes and 172 second prizes.

Link of Shaanxi Provincial Department of Education notice:

http://jyt.shaanxi.gov.cn/news/gsgg/202204/25/20446.html

GPM 材料文化创意作品大赛举行决赛

GPM Materials Creative Contest concludes

4月23日，由团队联合共青团陕西师范大学委员会主办的“GPM材料文化创意作品大赛”决赛在新勇学生活动中心举行，22个入围参赛团队进行了决赛现场答辩，最终评委评出14件拟获奖作品，其中一等奖1项，二等奖3项，三等奖10项，其余参赛作品拟获入围纪念奖。获奖名单将于公示后在近期举行的颁奖仪式上正式公布。

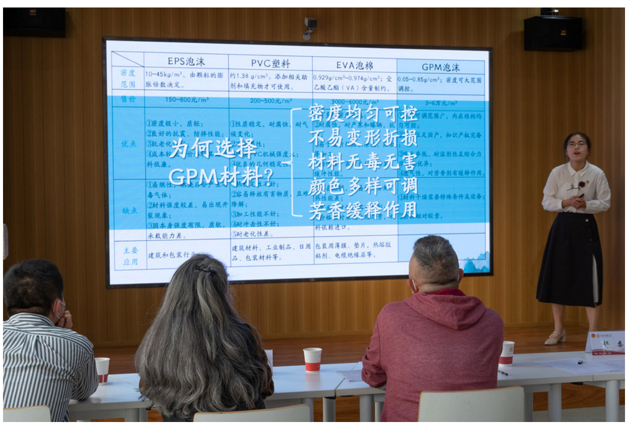
此次大赛于2021年12月开始征稿，共收到43件参赛作品，经过专家评审，22件参赛作品入围决赛。一二三等奖获奖团队将分别获得5000元、3000元和1000至的奖金及荣誉证书。

GPM（Gas Permeable Monolith）是迄今为止尚未见诸报道的高强透气有机材料，由房喻院士为首的光子鼻与分子材料团队经由多年努力研制而成。

本次大赛的主题为“逐梦师大，创引未来”，面向全校在籍学生征集结合材料特性和功能开发设计的文化创意产品，旨在引导广大师生热爱科学，激发师生创新潜能，促进学科交叉融合。

团队彭军霞副教授、专职科研助理王佩在房喻院士指导下，策划并与学校团委有关老师全程组织实施了此项工作。应用表面与胶体化学教育部重点实验室严军林副主任对此项工作给予了大力支持，国际商学院韩菁教授，美术学院王晓庆副教授、王进华副教授，化学化工学院团委书记杨小刚老师，团委副书记王蓓蓓老师，和彭军霞老师担任了决赛评委。

四月份大事记 Events in April, 2022



On April 23, the GPM Materials Creative Contest, organized by Communist League Shaanxi Normal University Committee and Photonic Nose and Molecular Materials Group was held at Xinyong Student Activities Center.

After the presentation by the 22 shortlisted teams, the jury selected fourteen entries to be the winners, including one first prize, three second prizes and ten third prizes. The final list of winners will be announced at a awarding ceremony to be held soon after online public notice.

The contest received 43 entries after call for submission in December 2021 and 22 were shortlisted. The first, second and third prize winners will receive cash prizes of CNY 5,000 yuan, 3,000 yuan and 1,000 yuan and certificate of award.

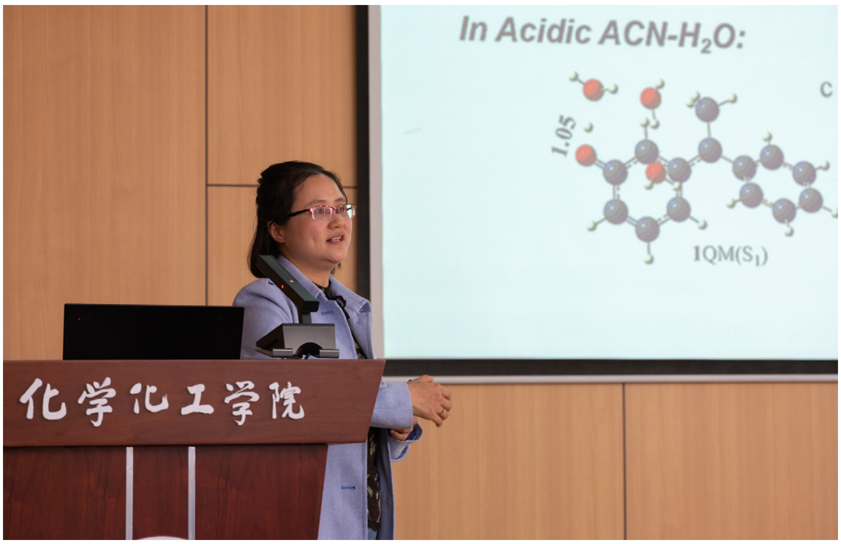
Gas Permeable Monolith, a proprietary strong breathable organic material, is developed by the photonic nose and molecular material group led by academician Fang Yu after years of R&D efforts.

Themed “Chasing dream at SNNU, Innovate toward future”, the contest call for creative cultural product designs integrating features and functions of GPM material from SNNU students, aiming at advocating love for science, stimulating potential of innovation and promoting interdisciplinary integration.

Assoc. Prof. Peng Junxia and research assistant Wang Pei planed and coordinated with Communist League Shaanxi Normal University Committee to organize this contest. Ministry of Education Key Lab of Applied Surface and Colloid Chemistry vice director Yan Junlin gave his support to the event. Prof. Han Jing of International Business School, Assoc. Prof. Wang Xiaoqing and Wang Jinhua of School of Fine Arts, Youth League SCCE Committee secretary Yang Xiaogang, Youth League SNNU Committee vice secretary Wang Beibei and Peng Junxia served as the jury.

马佳妮教授做有机光化学反应学术报告

Ma Jiani presents her research on organic photochemical reaction



4月7日下午，马佳妮教授应邀在致知楼1668报告厅为团队师生作了题为“有机光化学反应机制研究”的学术报告。房喻院士、薛东教授、丁立平教授、刘静教授、刘凯强研究员、彭军霞副教授、刘太宏副教授、彭浩南副教授、苗荣副教授、刘忠山副教授及团队全体博士生、研究生聆听报告。报告由刘静教授主持。

此次报告中，马佳妮教授围绕有机小分子光化学反应机制等内容对其课题组近期的科研进展作了详细介绍，并对瞬态吸收光谱在研究超快反应动力学中的应用进行了系统分析。报告结束后，马佳妮教授与在座师生进行了热烈讨论，对师生的积极提问给予了详细深入的解答。

On April 7, Prof. Ma Jiani was invited to present her research in a lecture on the mechanism of organic photochemical reaction at the lecture room 1668 in Zhizhi building.

Prof. Fang Yu, Prof. Xue Dong, Prof. Ding Liping, Prof. Liu Jing, Research fellow Liu Kaiqiang, Assoc. Prof. Peng Junxia, Assoc. Prof. Liu Taihong, Assoc. Prof. Peng Haonan, Assoc. Prof. Miao Rong, Assoc. Prof. Liu Zhongshan and the graduate students of Photonic Nose and Molecular Materials Group attended the lecture.

In her lecture, Ma Jiani presented a detailed introduction of her group's recent research progress in the organic small molecule photochemical reaction, as well as a systematic analysis of application of transient absorption spectroscopy in the study of ultrafast reaction kinetics.

She also answered questions from the audience and discussed topics they brought up.

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Structural Dynamics of Short Ligands on the Surface of ZnSe Semiconductor Nanocrystals

Hongxing Hao,[†] Jingwen Ai,[†] Chenxiao Shi, Dexia Zhou, Lingbo Meng, Hongtao Bian,* and Yu Fang

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半导体纳米晶体表面配体结构动力学研究进展

半导体纳米晶体 (NCs) 作为一种新型材料，在太阳能电池、化学传感和生物成像等领域具有重要的应用价值。表面配体的种类和结合状态可以极大地调节和控制 NCs 的光学和电学性能，理解配体的超快结构动力学行为已逐渐成为该领域的研究热点。受传统研究手段的局限，在分子层次上理解表面配体的超快动力学行为并未得到深入研究，具有飞秒（10^{-15} s）时间分辨能力的超快红外光谱技术可以用于解析纳米晶体表面配体的结构和超快动力学过程。

研究亮点：

1. 首次利用超快红外光谱研究了胶体溶液中 SCN^- 阴离子配体在 ZnSe 纳米晶体表面的超快动力学过程；

2. 自由形态下的 SCN^- 阴离子和与 ZnSe NCs 表面相互作用的 SCN^- 阴离子配体的振动弛豫动力学和转动动力学进行详细表征，并探究了 NCs 的尺寸依赖效应；

3. 基于锥摆模型对 ZnSe NCs 表面配体的微观动态结构进行分析。

本研究以 ZnSe NCs 表面 SCN^- 阴离子配体为研究主体，并作为红外探针来揭示溶液中 NCs 表面配体超快动力学过程。研究表明，与 ZnSe NCs 表面相互作用的 SCN^- 阴离子具有更短的振动寿命并且不受 NCs 的尺寸效应影响。而转动时间常数明显变大且具有明显尺寸效应。基于锥摆模型分析，SCN^- 阴离子配体在 NCs 表面以较大的角度进行定向扩散，并且其整体定向扩散强烈依赖于 NCs 的尺寸大小。本研究首次利用超快红外光谱研究了溶液中 ZnSe NCs 表面 SCN^- 阴离子配体的振动弛豫动力学，为理解胶体溶液中半导体纳米晶体表面配体的结构和动力学提供了微观层次的认识。

第一作者：陕西师范大学硕士毕业生郝宏星（现就读于德国慕尼黑工业大学化学系）、硕士研究生艾静雯
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全文链接：https://pubs.acs.org/doi/pdf/10.1021/acs.jpclett.2c00849

Semiconductor Nanocrystals (NCs) make up a novel class of materials and have been demonstrated to have potential applications in the fields of solar cells, chemical sensing and bioimaging. The most fascinating feature of the colloidal NCs is that their optical and electronic properties can be greatly tuned and controlled by the ligands, either physically adsorbed or chemically modified on the surface of NCs. Fundamental understanding of the structure and dynamics of the surface ligands on the NCs has received extensive attention.

科研亮点 Research Highlights

Due to the limitation of traditional techniques, the ultrafast structural dynamics of the surface ligands at the molecular level is still lacking. The ultrafast IR spectroscopy with femtosecond time resolution has been demonstrated as a powerful technique to unravel the structure and dynamics of the surface ligands on NCs.

Research highlights:

1. The ultrafast structural dynamics of thiocyanate ligands on the ZnSe NCs was investigated by ultrafast IR spectroscopy for the first time.

2. The vibrational relaxation dynamics and rotational dynamics of free thiocyanate anion and bound thiocyanate ligands were analyzed in detail, where a clear size dependent effect was observed.

3. The microscopic structural dynamics of surface ligands on ZnSe NCs was analyzed based on the wobbling-in-a-cone mode.

In this study, the short ligand of thiocyanate anions is utilized as the IR reporter to reveal the structural dynamics on the surface of ZnSe NCs. Vibrational population relaxation of SCN ligands is accelerated due to the specific interaction and is not affected by the size. However, the orientational anisotropy of the bound SCN ligands decayed at a rate much faster than that in its free form and clearly showed the size-dependent effect. Based on the wobbling-in-a-cone analysis, the SCN ligands undergo wobbling orientational diffusion with a relatively large cone semiangle on the surface of ZnSe NCs, and the overall orientational diffusion of the bound SCN is strongly dependent on the size of NCs. We report the first example of the ultrafast structural dynamics of thiocyanate ligands on the ZnSe NCs by ultrafast IR spectroscopy. It is expected that the current study would benefit the microscopic understanding of the structure and dynamics of the surface ligands on the semiconductor NCs in the colloidal solution.

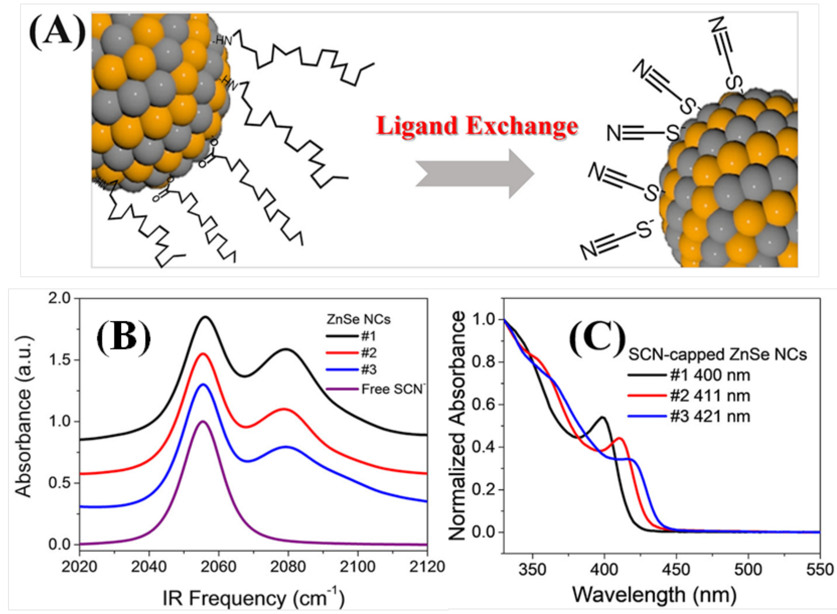

图 1.(A) 疏水基团长链与 ZnSe NCs 表面的 SCN 之间的配体交换示意图。(B) 分散在 DMSO 溶液中的不同直径的 ZnSe NCs 表面上 SCN 配体的自由形式 (2055 cm−1) 和结合形式 (2080 cm−1) 的归一化 FTIR 光谱。为清楚起见，FTIR 光谱已垂直偏移。还绘制了溶解在纯 DMSO 溶液中的游离 SCN 阴离子（0.02 mol NaSCN/kg）的 FTIR 光谱以进行比较。(C) 具有三种不同直径的 ZnSe NC 的归一化 UV−vis 光谱。ZnSe NC 的直径确定为 5.6 nm (#1)、6.5 nm (#2) 和 8.5 nm (#3)。

Figure 1. (A) Schematic representation of the ligand exchange between the long chain of the hydrophobic group and the SCN on the surface of ZnSe NCs. (B) Normalized FTIR spectra of the SCN ligand in its free form (2055 cm−1) and the bound form (2080 cm−1) on the surface of ZnSe NCs with different diameters dispersed in the DMSO solutions. The FTIR spectra have been vertically offset for the sake of clarity. The FTIR spectrum of the free SCN anion (0.02 mol of NaSCN/kg) dissolved in the pure DMSO solution is also plotted for comparison. (C) Normalized UV−vis spectra of the ZnSe NCs with three different diameters. The diameters of the ZnSe NCs were determined to be 5.6 nm (#1), 6.5 nm (#2), and 8.5 nm (#3).

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RESEARCH ARTICLE | Open Access

A fluorescent film sensor for high-performance detection of *Listeria monocytogenes* via vapor sampling

Rongrong Huang, Meiqi Li, Dehui Lin, Yangtao Shao, Congdi Shang, Qianqian Liu, Guijun Liu, Nan Li, Rong Miao, Haonan Peng, Yanli Tang, Yu Fang

First published: 28 April 2022 | https://doi.org/10.1002/agt2.203

薄膜荧光传感器用于单核增生李斯特菌的高效、实时检测

本工作首次报道一种经由气相信号物质高效检测单核增生李斯特菌的薄膜荧光传感器（Fluorescence Film Sensors, FFSs）。

食品污染是当今世界最受关注的公共安全问题之一。食品污染引发原因众多，其中食源性单核增生李斯特菌污染最为常见，致死率可达25%，后果极为严重。单核增生李斯特菌广泛存在于蔬菜、水果、乳制品、家禽等食材中。与其它食源性致病菌不同，单核增生利斯特菌存活能力极强，在低温环境（冰箱）下依然能够存活并繁殖。因此，早期发现对于预防单核增生李斯特菌感染意义重大。

单核增生李斯特菌在繁殖生长过程中会持续释放 3– 羟基 –2– 丁酮，且浓度与单核增生李斯特菌多少直接相关。因此，3– 羟基 –2– 丁酮常被用作信号物质监测 / 检测单核增生李斯特菌的存在。在本工作中，作者团队借助薄膜荧光传感所具有的灵敏度高、响应速度快、可逆性好和易于器件化等特点，发展了一种以邻碳硼烷吡咯衍生物为敏感单元的 3– 羟基 –2– 丁酮蒸气薄膜荧光传感器。研究标明，该传感器对气相

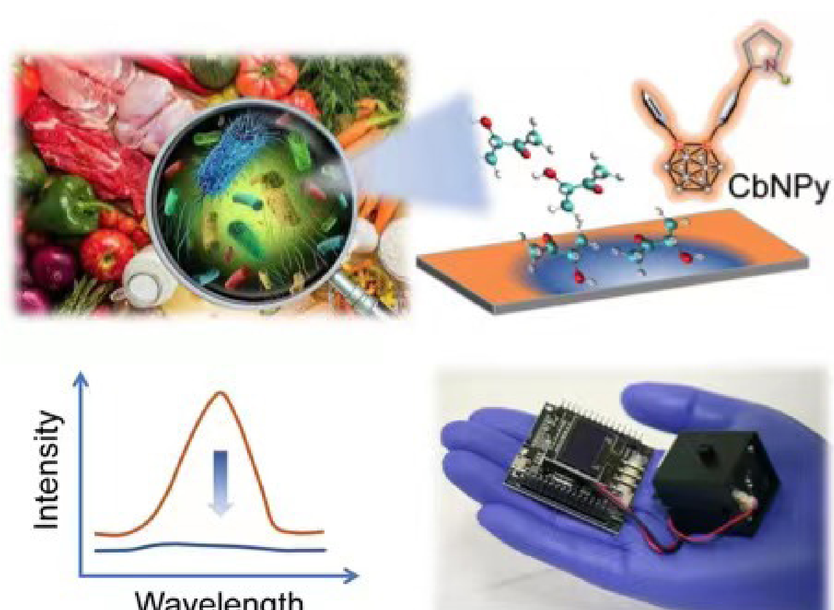

图 1. 所研发的便携式荧光传感器对食物中单核增生李斯特菌的检测示意图。
Figure 1.Schematic illustration for the detection of Listeria monocytogenes using a portable fluorescent sensor.

3–羟基–2–丁酮响应迅速、恢复性好、选择性高，且稳定性优异。对目标物质—3–羟基–2–丁酮检出限可达 0.05 mg/m3（0.02 ppm）以下。进一步的研究表明，利用所发展传感器可以极为方便地确定肉、牛奶等食材是否存在单核增生李斯特菌。

本工作所报道薄膜荧光传感器的核心组件荧光敏感薄膜经由原创的非平面结构邻碳硼烷吡咯衍生物组装而成，活性层（adlayer）富含孔道结构，有助于传质。此外，薄膜光化学稳定性突出，且敏感物质——邻碳硼烷吡咯衍生物可经由氢键作用特异缔合 3–羟基–2–丁酮，从而实现对单核增生李斯特菌信号物质选择性富集，以及对邻碳硼烷吡咯衍生物荧光性质的大幅度扰动。上述几个因素决定了此荧光敏感薄膜和薄膜荧光传感器对单核增生李斯特菌的高性能传感。

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全文链接：https://onlinelibrary.wiley.com/doi/full/10.1002/agt2.203

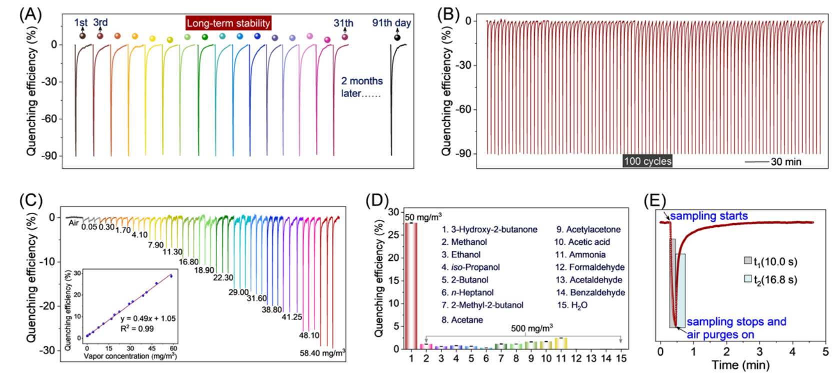

图 2. 该传感器对 3–羟基–2–丁酮气体的响应情况
Figure 2. Sensing performance of the gas sensor to 3-hydroxy-2-butanone

In the present work, we report for the first time fluorescence film sensors (FFSs) to detect the biomarker of L. monocytogenes.

Listeria monocytogenes, one of the most hazardous bacteria with a mortality rate as high as ~25%, is widely found in vegetables, fruits, dairy products, poultry, and other foods.[1] They can breed over a wide range of temperatures (0-45℃), high-salinity, and low-moisture environments. Patients infected by L. monocytogenes may suffer from bacteremia, complications, and meningitis, especially pregnant women, infants, young children, the elderly, and the sick. Therefore, it is of urgent demand to develop the rapid, noninvasive, and easy-to-operate technique for the real-time and on-site detection of L. monocytogenes.

3-Hydroxy-2-butanone is the main component of the volatile metabolites of L. monocytogenes, and its concentration is highly dependent on breeding time. Therefore, sensitive and selective detection of 3-hydroxy-2-butanone has become an efficient method for detecting L. monocytogenes in food. Compared to other techniques, film-based fluorescence sensors demonstrate great sensitivity, improved selectivity, and unprecedented designability. Herein, a fluorescence sensor was constructed, which demonstrated unprecedented sensing performance for 3-hydroxy-2-butanone with a detection limit lower than 0.05 mg/m3, response time less than 1 s, full reversibility, and excellent selectivity. Further study showed that the sensor can be used to monitor the growth of L. monocytogenes with much-improved sensitivity. The superior performance of the sensor is ascribed to the specific binding, efficient charge transfer emission, and porous adlayer structure of the specially designed sensing fluorophore-based film. Our work paves the way to develop a portable detector to meet the needs for on-site and real-time detection of foodborne pathogens.

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Full Text Link: https://onlinelibrary.wiley.com/doi/10.1002/agt2.203

ADVANCED MATERIALS TECHNOLOGIES

Research Article

A Mono-Boron Complex-Based Fluorescent Nanofilm with Enhanced Sensing Performance for Methylamine in Vapor Phase

Min Li, Yan Luo, Jinglun Yang, Yanyu Qi, Rongrong Huang, Gang Wang, Jianfei Liu, Zhongshan Liu, Yu Fang ✉

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荧光纳米膜气 / 液界面控制制备与传感应用

光学传感器，尤其是薄膜荧光传感器，具有灵敏度高、选择性好、易于制备等优点，因此被广泛应用于诸多物质的气相检测。就薄膜荧光传感器而言，最核心的部分是其中的传感薄膜。在过去的研究中，研究人员利用滴涂、旋涂、LB 膜等方法，创制出了各式各样的薄膜，获得了一系列重要的应用，但这些方法多存在咖啡环效应、厚度难以精确控制、重现性不好、基质效应明显等这样或那样的问题。为此，亟需发展新的薄膜制备策略。

一般而言，在传感薄膜研制过程中，调控并优化薄膜层内部结构（Adlayer）尤为重要，这是因为其极大地影响着薄膜的响应动力学，也影响着薄膜的选择性。不过需要注意的是，Adlayer 结构调控并非易事，需要从表界面科学出发，发展新的策略。

基于以上考虑，本工作通过自主设计合成的四配位有机硼化合物（BQ–CHO）与均苯三酰肼（BTH）在气液界面的动态共价键反应，制备了一种自支撑、无缺陷、表面均匀平整的荧光纳米薄膜。薄膜厚度可在数十到数百纳米范围内严格控制。薄膜孔道结构极其丰富，可以很好地满足高性能传感所要求的高效传质和传感单元高效利用等。在自主搭建的传感测试平台对所组装的概念性薄膜荧光传感器性能测试表明，薄膜对胺类气体，尤其是甲胺具有高灵敏度和高选择性响应，实验检出限低于 2.82 mg/m3。

界面限域动态共价键缩合方

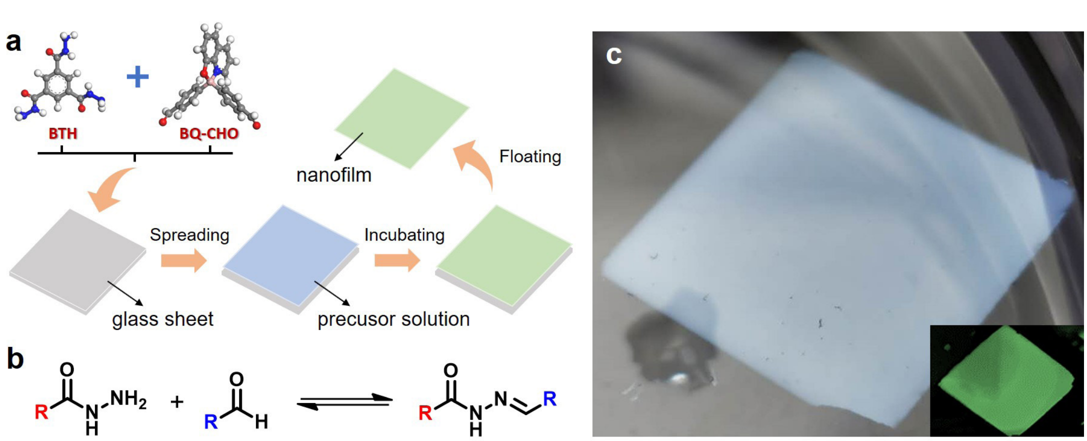

图 1.BTH–BQ 纳米薄膜的 (a) 制备过程，(b) 动态共价缩合反应，(c) 实物图展示，插图为薄膜暴露于紫外灯下的荧光照片。
Figure 1.(a) Presentation of the structures of two building blocks, BTH and BQ-CHO, and schematic representation of the formation process of the fluorescent nanofilm. (b) The dynamic covalent reaction between the two building blocks. (c) A picture of the nanofilm floated on water. Inset: The film under UV light.

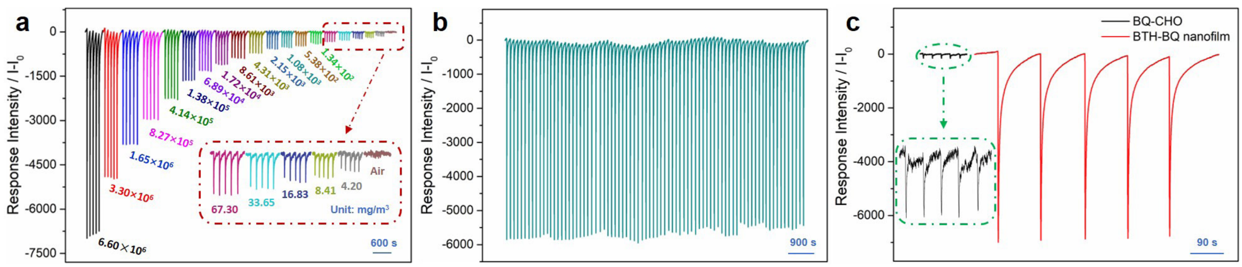

图 2.（a）纳米薄膜对不同浓度的甲胺气体的响应情况。（b）纳米薄膜的重复性测试。（c）纳米薄膜与荧光化合物滴涂的薄膜对饱和甲胺气体的响应对比。

Figure 2. Sensing performance of the sensor to MA. (a) Fluorescent responses of the nanofilm to MA with different concentrations. (b) Reproducibility test upon 80 cycles of the nanofilm to MA vapor. (c) The sensing of the nanofilm and BQ-CHO-based film to saturated MA vapors. Every test was repeated for five times.

法不仅可以有效解决传统薄膜存在的传感单元利用率不高问题，而且可以大幅度提高薄膜的光化学稳定性。此外，与传统薄膜相比，以界面限域策略得到的薄膜可以独立使用，也可用于柔性基质，从而可以避免基质效应对薄膜结构和性能的影响，也为薄膜荧光传感器的柔性化发展提供了可能。

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Optical sensors, especially film-based fluorescent sensors, owing to their multiple advantages, such as high in sensitivity, small in size, and low in energy consumption, provide a method for the fast discrimination and detection of a variety of chemicals. The high-performance sensing film is the key element of a film-based fluorescent sensor. In fact, numerous fluorescent films have been developed by different fabrication methods, such as drop-casting, spin-coating and Langmuir-Blodgett, which are highly efficient but suffer from coffee-ring effect, uncontrollable thickness and adlayer structures, etc. Thereby, new strategies for fabrication of high-performance fluorescence sensing films need to be developed.

To develop new sensing films, the optimization of adlayer structure is the principal factor that need to be considered which highly influences the sensitivity, selectivity, speed, and reversibility (3S + 1R) of a sensing process due to mass transfer-related reasons. It should be noted that new strategies need to be focused on interfacial science.

In this work, a uniform and defect-free fluorescent sensing film was fabricated using the dynamic-covalent bond-based interfacial self-assembly technique of two building blocks, BQ-CHO and BTH. The thickness of the BTH-BQ nanofilm can be freely tuned by changing the concentration of the casting solution, at least from 14 to 125 nm. The nanofilm-based sensor demonstrated excellent performance to the sensing of amines, especially MA with a detection limit (DL) lower than 2.82 mg m−3, which satisfies the requirement for air quality monitoring.

The nanofilm prepared by interfacially confined dynamic condensation can not only effectively solve the problem of low utilization rate of the sensor units existing in the traditional film, but also greatly improve the photochemical stability of the film. In addition, the prepared nanofilms possess abundant and uniform pore structures with minimized substrate effect, showing great potential for further exploration and laying foundation for flexible and even substrate-free film-based fluorescence sensing.

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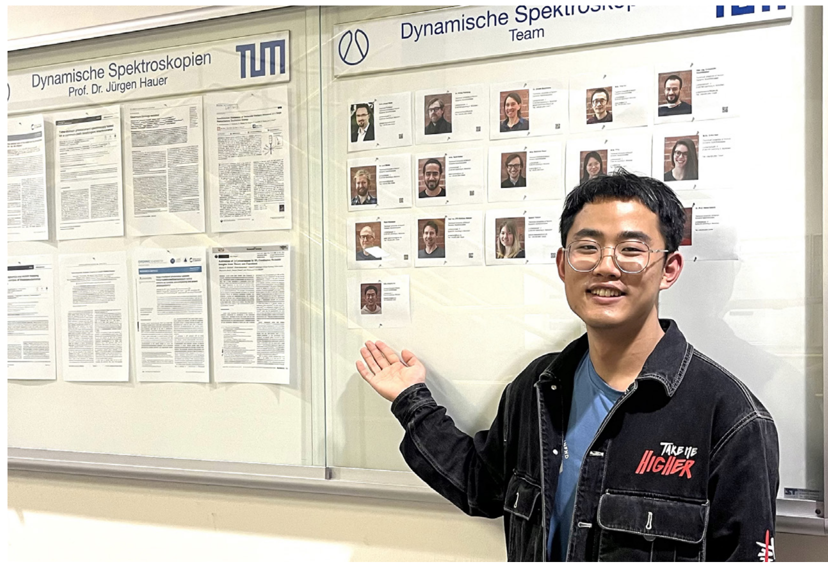
留学德国半年初体验

Six months in Germany: My Study Abroad Experience

郝宏星

我是 2021 年 10 月底来到德国慕尼黑的，现在就读于慕尼黑工业大学化学系的物理化学专业。转眼间已在德国求学半年，经常和朋友谈论的话题就是为什么要出国留学。这个问题直到现在我也不知道怎么回答，当初不知道出于什么想法莫名其妙申请了德国的学校。可能是从边老师突然给我推荐了一个马普所的职位招聘开始？谁都没办法在同一个时间经历两种生活，比如在国外留学，还是留在国内，所以更没办法说选择是对是错，是浪费还是值得。



在出国前的夏天参加了东师大的德语培训，当时老师用七个字形容德国生活：“好山好水好无聊”。这可能也是我刚来德国感受，很多的时候都是一个人，也没什么朋友。Su 之前说，每个人都在向我打招呼，但是他们只说了 Hi 就没有然后了，现在好像也轮到我了。不同的是，更多的时候是我自身的问题，语言是最主要的障碍，每次组里的 coffee time 和 lunch time 都是我最痛苦的时候。我只能看着他们聊天然后还怕被问到，坐在那里浑身不自在，特别尴尬。还是觉得平常学习的英语过于书面化，口语是软肋，在聊天的过程中很不自然，不知道怎么开玩笑等。建议师弟师妹们如果有时间，跟着美剧或者其他电视节目学习口语可能更实用一点。不过语言基本是每个留学生最初都会存在的问题，没必要太过于紧张。庆幸的是，虽然德国官方语言是德语，但在慕尼黑这样的城市，英语的普及度还是非常高的，有时候感觉装修工人和超市的服务员口语都比我好，这在最初真的让我吃惊。德国的冬天夜很长，每天下午四点天就已经黑了，好在春天已经来了，我也渐渐适应了这里的生活。

如果说德国的博士生培养有什么特点？可能最大的特点就是放养吧（相对于国内的博士培养而言），我可能要一两个周才会有机会和导师讨论实验。一切的进度都很慢，但又非常注意细节。目前只听说很少的课题组会非常 push，大部分的组在时间上都比较随意。德国的博士培养类似工作制度，是和导师或者员工部门等签订工作合同，并且会承担个税，医疗养老保险等。对于德国的化学博士职位，基本都是 2/3 的工作合同，这也就意味着每天只有 6 个小时的工作时间，绝大部分的全职合同只存在于计算机专业或者马普所等科研机构，经常会看到一些德国同事每天 10 点上班下午 5 点下班。但对中国人来说，由于教育背景和语言等

种种原因，按照这个工作时间是很难顺利毕业的，并且为了研究成果和文章，大部分时间不得不主动加班。我不是在讲这边有多好，对我而言，可能更怀念在硕士生涯充实的日子吧。

我在这边是一个不大不小的组，除了导师只有 6 个博士生和三个博士后，导师比较忙，是两个博士后在带我，其中一个负责软件和硬件，一个负责理论。在边老师实验室求学的时候，我有幸有过一些设备搭建的经验，但我刚到这边实验室的时候还是被震惊到了。我被分了一个新的光学超净间，映入眼帘的只有光学平台和几个零星的镜框镜片，真正的从零开始，一切对我来说都非常的陌生，或许当年千顺师兄和德霞师姐感觉也是这样？在这边一直在努力接受新的知识，组里的课题都偏向物理方向，并且几个博士生都是物理背景，做的也都是物理的事情。举一个简单的例子就是，我们组在化学系竟然是没有化学实验服的。刚来的时候每天晚上回家都要在 MOOC 上面看基础光学的视频，感谢国内的公开课资源。慢慢学着搭建光参量放大器，尝试压缩脉冲，使用干涉仪，理解一些之前没有仔细理解的概念。之前组里一直在用 FTIR，可以很简单测量化学品的红外光谱，但是直到现在，我可能也没有真正理解傅里叶变换的奇妙，也没想到傅里叶变换可能有各种不同的应用领域。对于计算机方面的知识，还记得边老师在一年级的时候就和我讲，要学习一下不同的程序语言，Labview 或者 Matlab 之类的，肯定会用得到，我一直拖着没有学直到毕业。但是刚到这边收到导师第一封邮件就是 Are you familiar with LabView or any other programming language? 看完真的极度后悔没有早点学习，没有听老师的话，现在组里除了我，每个博士生都至少会两种程序语言。幸好导师并没有多说什么，他总是笑着说，你是学生，你不是员工不是博士后，不会没有什么的。

总之，既然来了，总要继续下去。什么时候科研开始慢慢步入正轨的呢，可能是组里的师兄师姐给我耐心讲解课题的时候，是课题组同事经常给我发邮件询问是否需要帮助的时候，又或者是导师安慰我说不要急对进度还满意的时候？生活上也慢慢的有了一些朋友，大家可以假期在欧盟的各个国家去旅游，享受这边慢节奏的生活。这里真的大赞慕尼黑光子世界博览会，对光学相关的工作者来说，给人带来的震撼绝对是无语伦比的。

如果未来有机会，希望各位师弟师妹们也来国外体验一下，体验不同的生活、文化、科研环境，体验不同的风景，也欢迎在欧洲的伙伴来慕尼黑。真的非常想念组里的各位老师和同学，感谢边老师三年来的帮助，希望疫情早日消失，这样在假期就可以回国和大家一起相遇了。

I came to Munich, Germany at the end of October 2021 and am now studying physical chemistry in the Department of Chemistry at the Technical University of Munich. In the blink of an eye, I have been studying in Germany for half a year, and I often talk to my friends about why I want to study abroad. I don't know how to answer this question, and I didn't know why I applied to a German school in the first place. Maybe it started when Prof. Bian suddenly recommended me a job recruitment at Max Planck Institute? No one can experience two lives at the same time, such as studying abroad or staying in China, so there is no way to say whether the choice is right or wrong, whether it is wasteful or worthwhile.

In the summer before coming to Germany when I participated in the German training at Eastern Normal University, the teacher described German life in these words: "Good mountains and good rivers, but so boring." This may also be what I felt when I first came to Germany. Most of the time I was alone by myself and I don't have many friends. Su said before that everyone was greeting me, but they just said Hi and then there was no more. And it seemed like it was my turn. The difference is that more often than not, it is my own problem, as language is the main obstacle. Every coffee time and lunch time in the group are my most painful time. I could only sit and watch them chat, afraid of being asked, feeling awkward and embarrassed. I think that the English I learned is too written than spoken, and spoken English is my weakness. It is hard to speak naturally during chatting, not knowing how to joke properly. I would suggest that if you have time, it may be more useful to learn spoken language from American TV series or other programs. However, foreign language is basically an obstacle that every international student will meet at the beginning, so there is no need to be too nervous. Fortunately, although the official language in German is German, in a city like Munich, English is very popular. Sometimes I feel that the decoration workers and supermarket cashiers speak English better than me, which really surprised me at first. Winter nights in Germany are very long, and it is already dark at four o'clock in the afternoon. Fortunately, spring has come, and I have gradually adapted to the life here.

If there are any characteristics of doctoral training in Germany, perhaps the most unique is "Free-range Breeding" (compared to the doctoral programs in China), and it may take me a week or two to have the opportunity to discuss experiments with my advisor. Everything was slow, but with great attention to detail. At present, I have only heard that a small number of research groups will be very pushy, and most of other groups are more casual in time. German doctoral programs are similar to the work system, which means signing a work contract with the advisor or personnel department, who will pay the individual tax and medical pension insurance, etc. A German doctoral candidate in chemistry is basically on a 2/3 work contract, which means only 6 hours working time a day, while most of the full-time contracts only exist in computer science majors or scientific research institutions such as Max Planck Institute. It is not rare to see some German colleagues go to work at 10 o'clock in the morning and leave for home at 5 pm every day. But for most Chinese students, due to various reasons such as educational background and language, it is difficult for them to graduate smoothly according to this working schedule, and most of the time they have to take the initiative to work overtime for research results and articles. I am not saying how good it is here in Germany, but for me, I probably miss the fulfilling days when I was a master's student back in China.

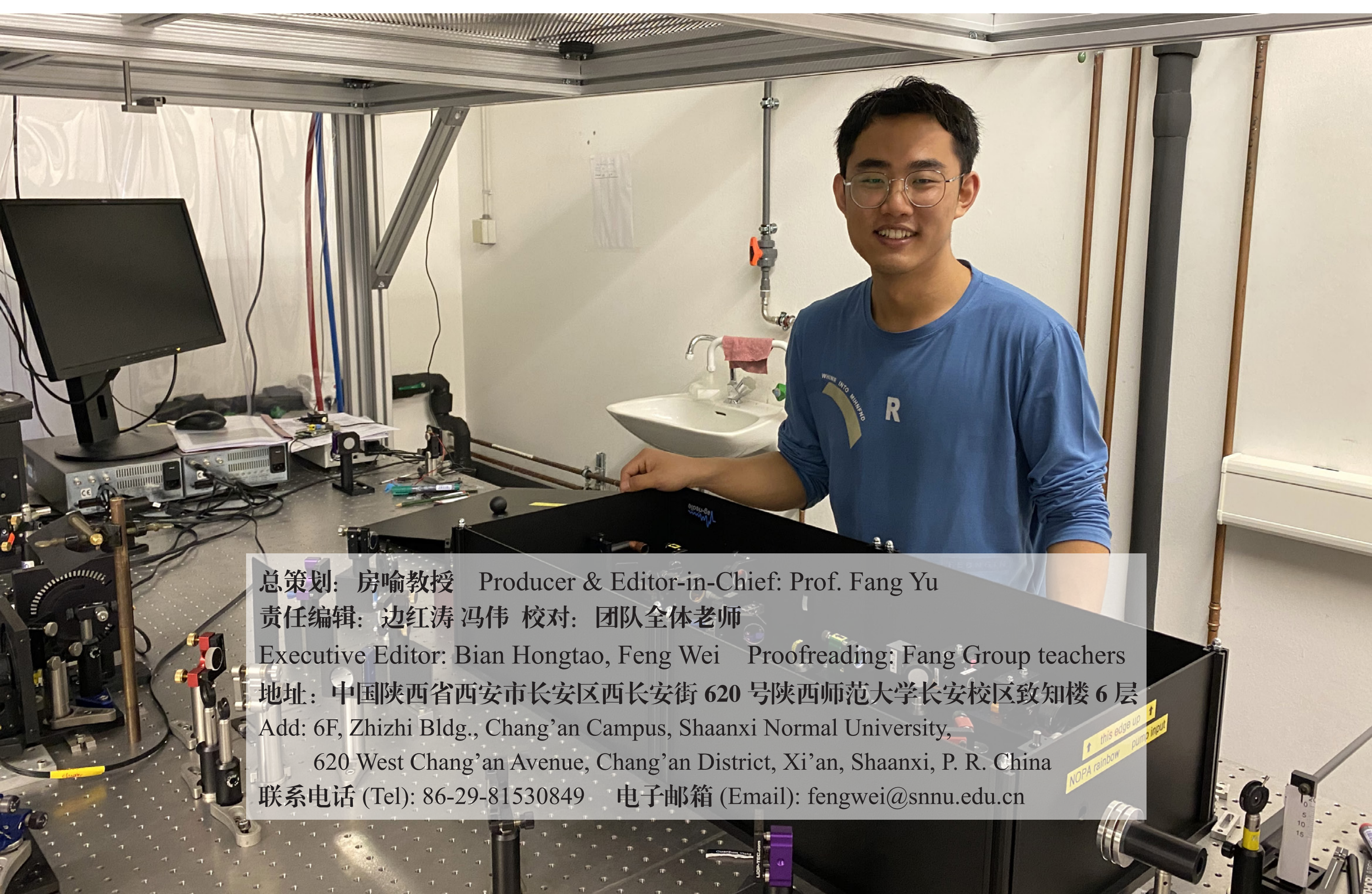
I am with a small group here, with only 6 doctoral students and three postdocs. My advisor is always busy, so two postdocs are coaching me, one responsible for software and hardware and the other the theory. When I was studying in Prof. Bian's lab, I had some experience in building equipment, but I was shocked when I first arrived at this lab. When I was assigned to a new optical ultra-clean room, all that came into my eyes was the optical platform and a few lenses, so I was really starting from scratch and everything was very strange to me. Maybe Qianshun and Dexia felt the same way when they first came into the lab in a foreign university? Here I have been trying to acquire new knowledge. The research topics of this group are mostly in physics, and several doctoral students are from physics backgrounds, doing physics research. A simple example is that no one in our group (in the chemistry department) wears chemical lab gown. During the period after I arrived here, I would watch videos of basic optics on the Chinese MOOC sites every night, my gratitude to the Chinese open class resources. Gradually I learned to build optical parametric amplifiers, tried compression pulses, used interferometer, and began to understand some concepts that were not thoroughly understood before. We had been using FTIR before in our group at SNNU, which could easily measure the infrared spectrum of chemicals. But until now, I probably did not really understand the wonder of the Fourier transform, nor did I think that the Fourier transform might have a variety of different

心绪感悟 Thoughts and Reflections

applications. For computer knowledge and skills, I remember Prof. Bian told me when I was a first-year Master's student to learn different programming languages, Labview or Matlab and the like, which will definitely be useful, but I did not learn before graduation. But the first email I received from my advisor when I got here was "Are you familiar with LabView or any other programming language?" I really regret that I did not follow Prof. Bian's advice to study earlier, as every doctoral student in the group except me knows at least two programming languages. Fortunately, my advisor didn't say much, instead he smiled and told me that "it's all-right. You are a student, not an employee or a postdoc."

In short, since I have come, I will carry on. When will my research move on the right track? It may be when the senior students in the group patiently explain the topic to me, or when colleagues in the group send me emails to ask if I need help, or when my advisor comforts me and says take your time and he is satisfied with my progress? Also I began to make some friends in life. We can travel to various countries of the European Union during the holidays and enjoy the slow pace of life here. Here I would like to sing the praise of the Munich Photonics World Exposition, as for a optics researcher, the shock is absolutely incomparable.

If there is an opportunity in the future, I sincerely hope that my junior fellow students will also come study abroad, experiencing a different life, culture, and scientific research environment, and experiencing the different scenery. And I welcome friends in Europe to come to visit me in Munich. I really miss the teachers and classmates in Fang group, and I would like to thank Prof. Bian for his help in the past three years. I hope that the COVID epidemic will disappear as soon as possible, so that I can return to China and meet everyone during the holidays.



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