

**A**ir-quality & **E**nergy-saving in **C**onfined **S**paces (**AECS**)

2022 Bulletin @ Dept. of Building Science, Tsinghua University <http://jmo-lab.net>





taking a group photo before the International Workers' Day



**志向**

追求乐趣

提升人品

展现才华

贡献人类

**Slogans**

**Seek for funs!**

**Improve your personality!**

**Show your talents!**

**Contribute to humanity!**

**Tsinghua Spirit**

**“Actions Speak Louder than Words” (行勝於言)**

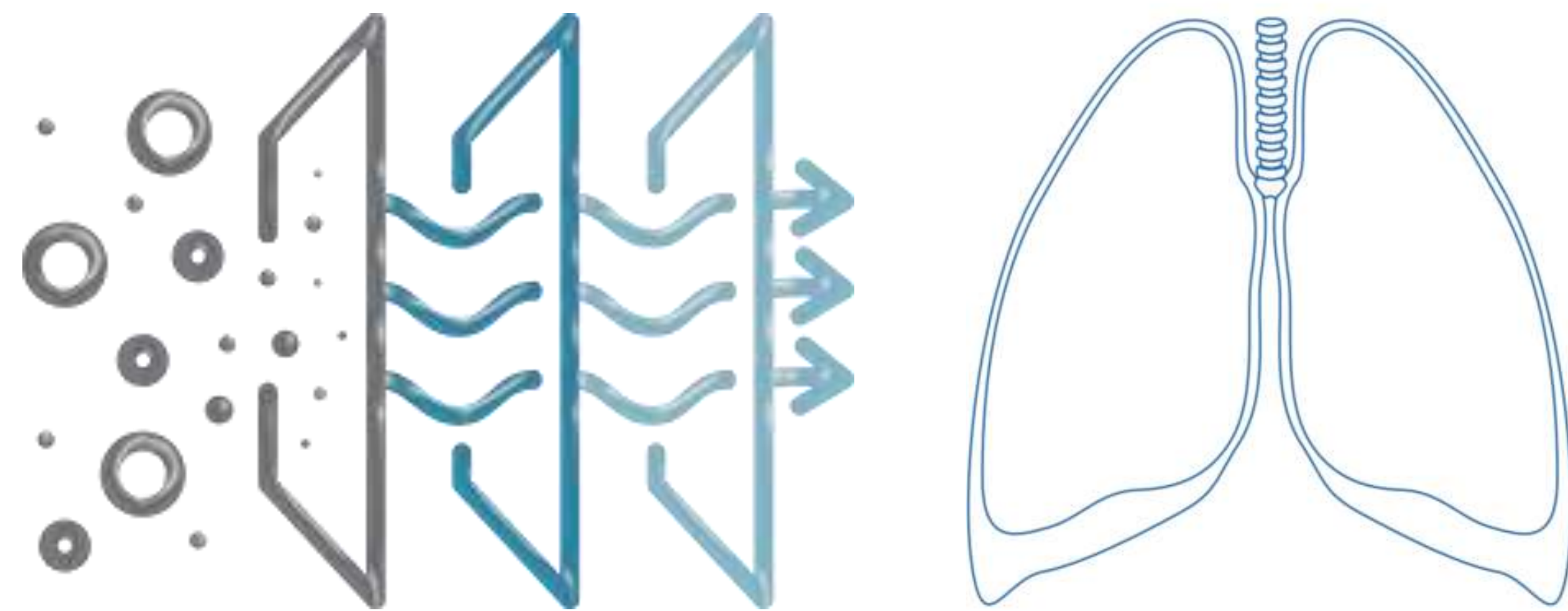


## Objectives

- From built environments to confined spaces
- From pollution to environmental control system
- From energy utilization to energy saving and storage

从建环到受限空间  
从污染到环控系统  
从用能到节能储能

In 2022, we updated our research objectives. Our group name is changed to “Air-quality & Energy-saving in Confined Spaces (AECS)”.



建筑空气质量与健康  
Air-quality & Health  
in Built Environments

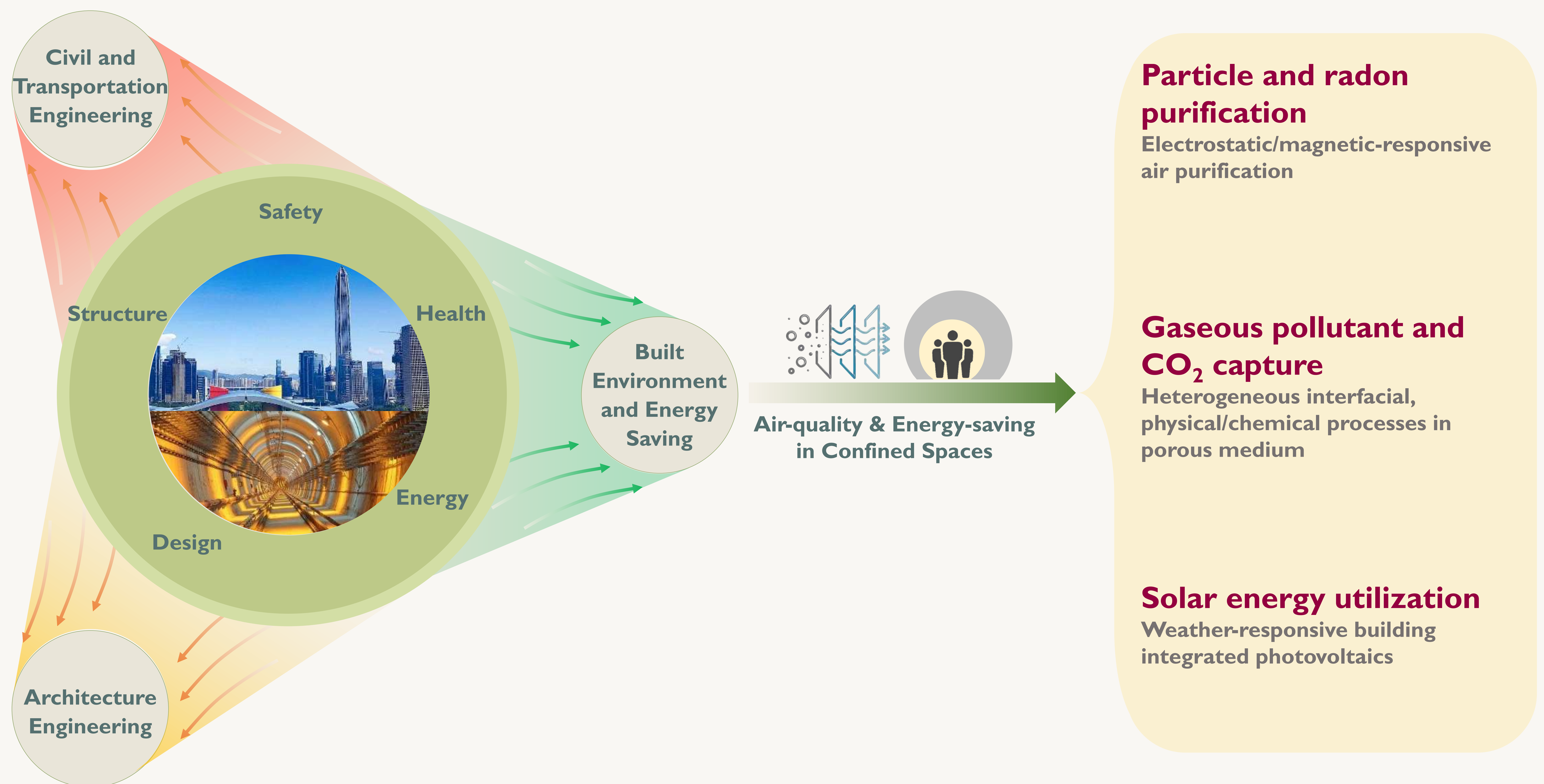


受限空间空气质量与节能  
Air-quality & Energy-saving  
in Confined Spaces  
AECS

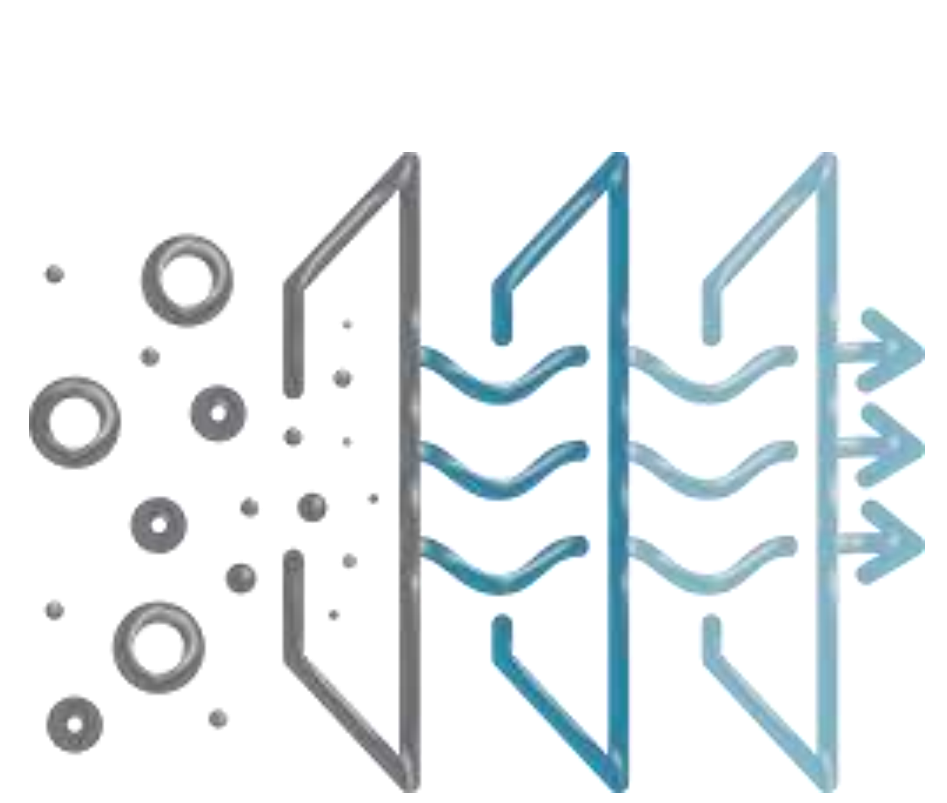




# Research   Activities   Fun







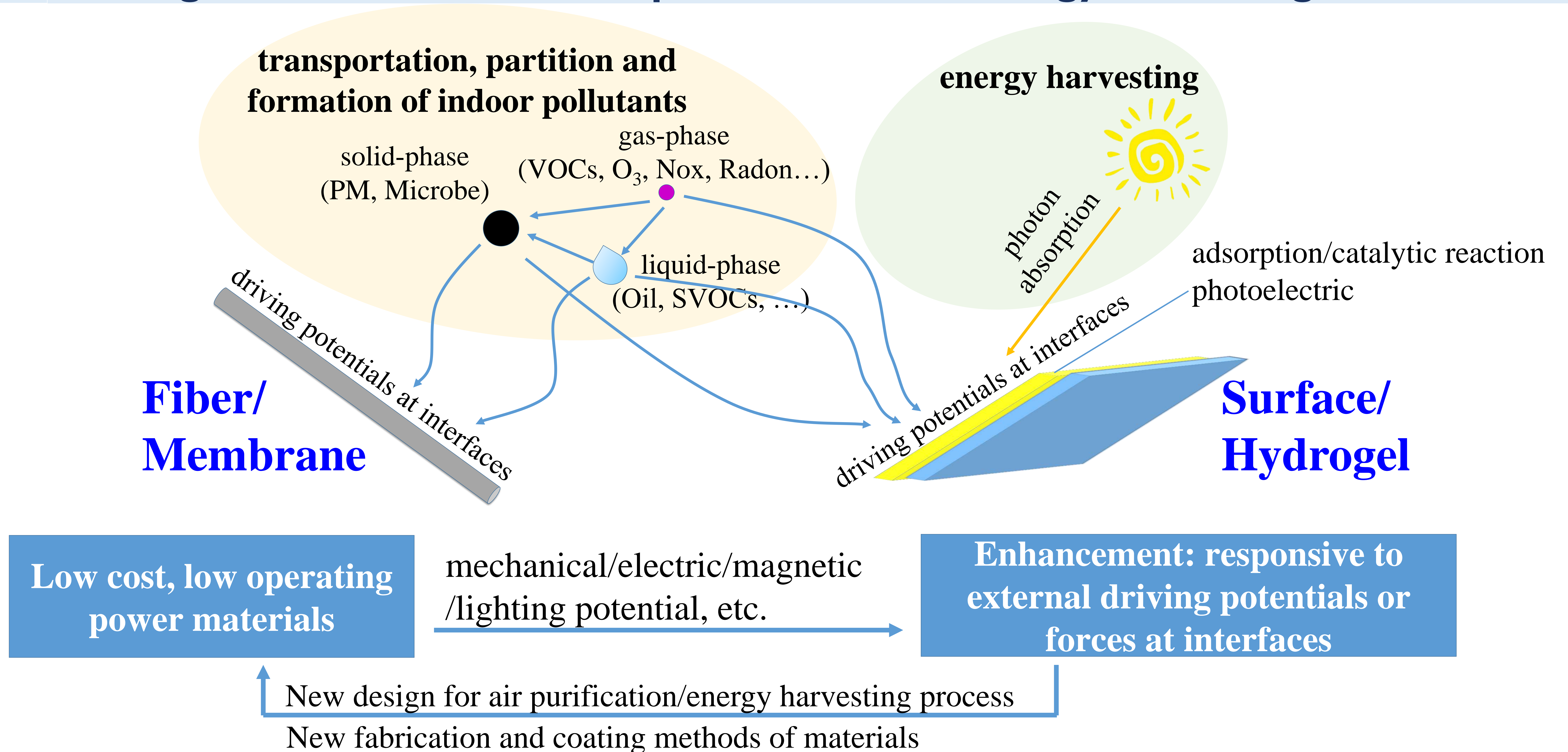
# Research

# Activities

# Fun

## Approaches

- Air pollution sensing, analysis and risk assessment for human health
- Heterogeneous interfacial, physical/chemical processes in confined spaces
- Design and fabrication of air purification and energy harvesting material/surface







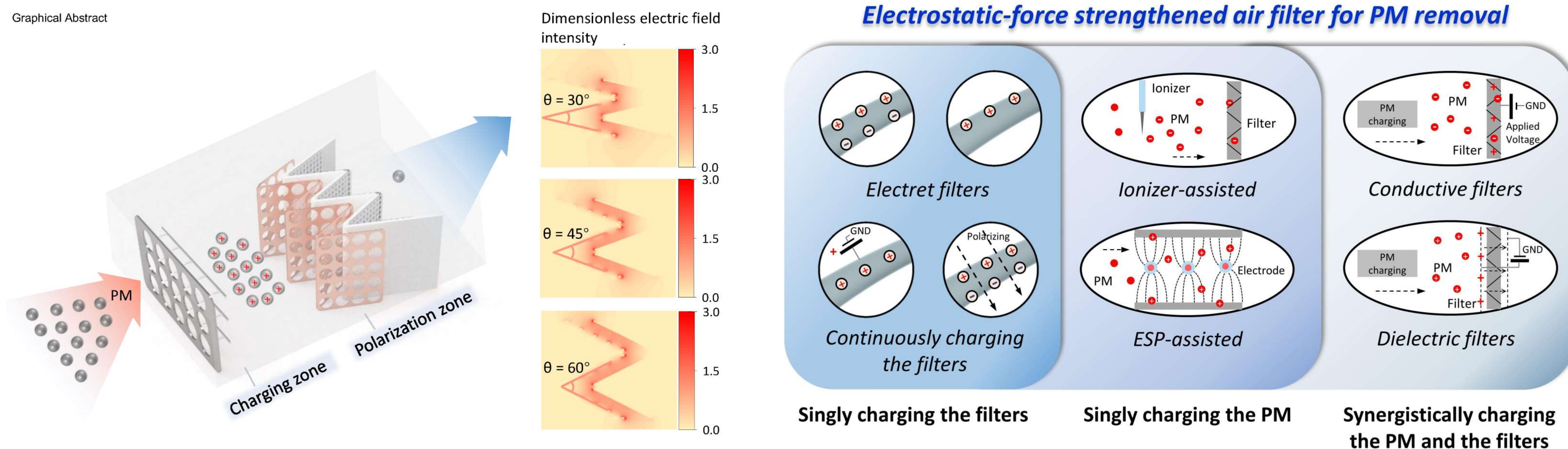
## Foldable electrostatically assisted air coarse filtration (EAA) by Yuting Gu and Enze TIAN

- We developed a foldable EAA coarse filters, in which the polarizing electrodes are shaped into zigzag structures and the coarse filter between the electrodes is folded with folding angles  $\theta = 30^\circ$ ,  $45^\circ$  and  $60^\circ$ . With an optimum  $\theta = 45^\circ$ , high filtration efficiency for submicron PM (85.0% for  $0.3\text{--}0.5\text{ }\mu\text{m}$  particles, 92.0 for  $0.5\text{--}1\text{ }\mu\text{m}$  particles) and low pressure drop (26.4 Pa) at high air duct velocity (3 m/s) are achieved.

Mo JH, Gu YT, Tian EZ\*, Separation and Purification Technology, 2022, 288, 120631.

<https://doi.org/10.1016/j.seppur.2022.120631>

Graphical Abstract



## A systematically review for the electrostatic air filters by Enze Tian and Yilun Gao

- We made a systematic review about the working principle for each category of electrostatic air filters, compare their initial and long-term performance for non-oily particles, oily particles, and bioaerosols, and provide specific research prospects.

Tian EZ, Gao YL, Mo JH\*, Building and Environment, 2023, 228, 109782. <https://doi.org/10.1016/j.buildenv.2022.109782>

## Air gas sensing by Enze TIAN

- High-density volatile organic compound monitoring network for identifying pollution sources.  
Li ZH, ..., Tian EZ, Liu KH\*, Jiang JK\*, et al. Science of The Total Environment, 2023, 855, 158872.
- Detecting residual chemical disinfectant using an atomic Co-Nx-C anchored neuronal-like carbon catalyst modified amperometric sensor

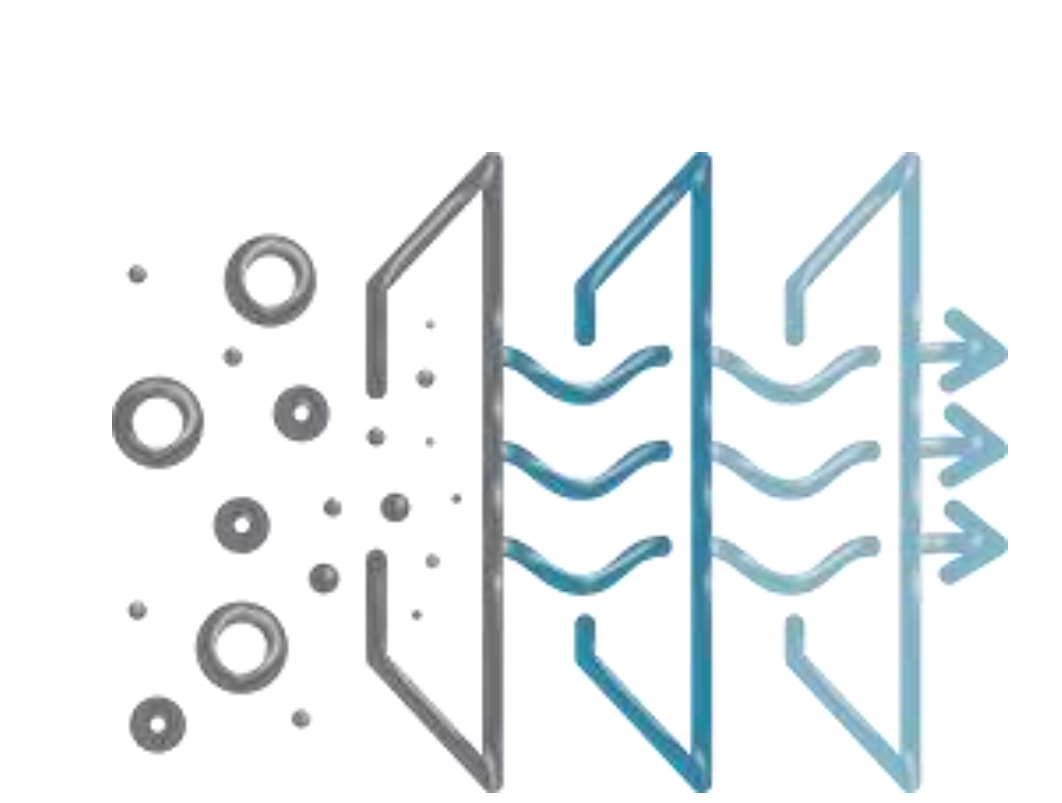
Li ZH, ..., Tian EZ, Tang C\*, Jiang JK\*, et al. Environmental Science: Nano, 2022, 9, 1759-1769.



Enze at the seaside in Guangdong.

She was approved to lead the Guangdong Basic and Applied Basic Research Foundation Project (2022A1515110897) and the China Postdoctoral Science Foundation Project (2022M723351)

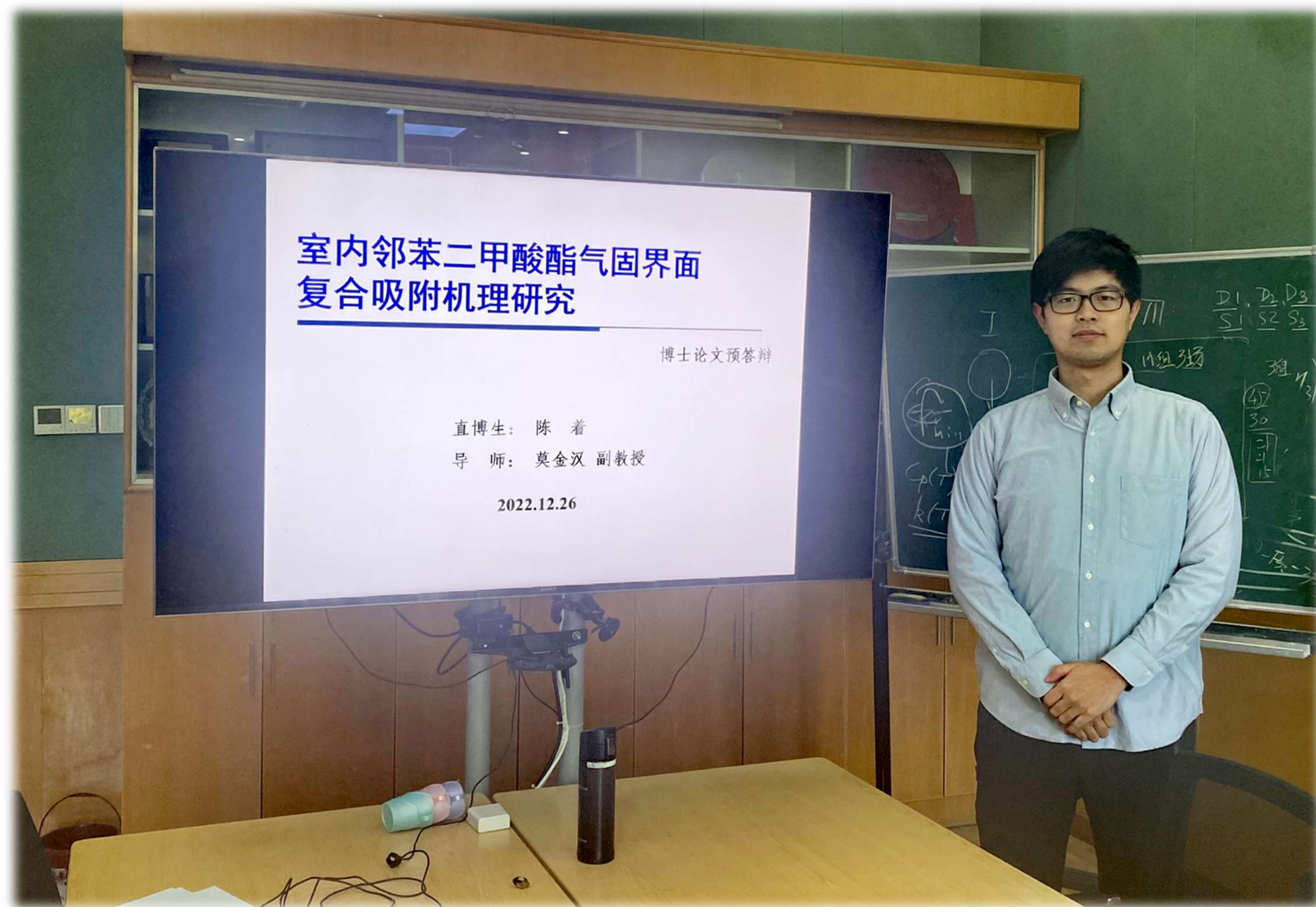




# Research

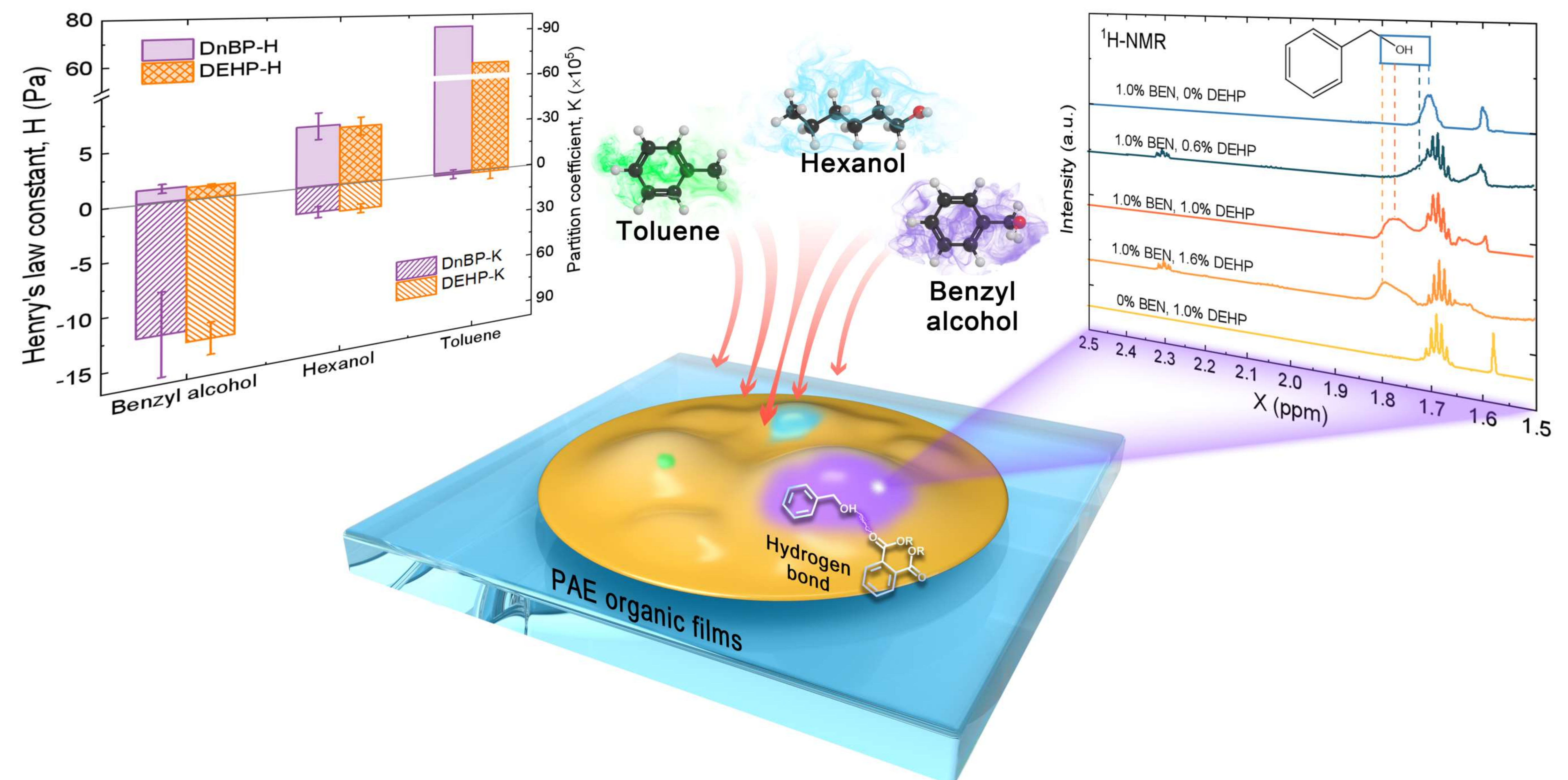
# Activities

# Fun



Zhuo CHEN is giving a pre-defense on his PhD thesis

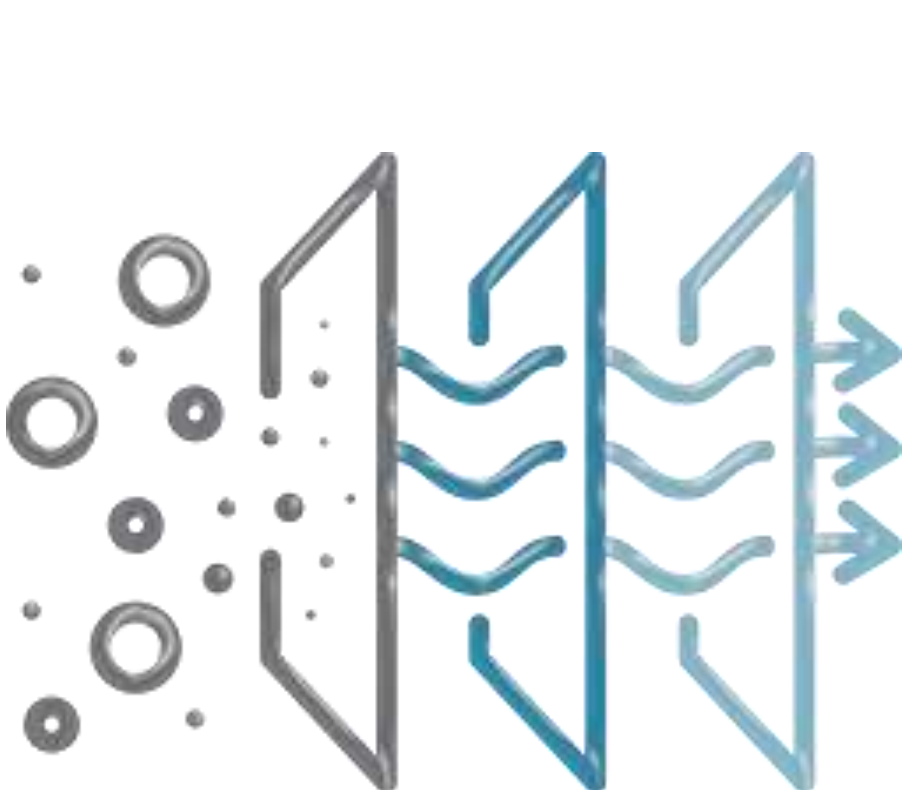
## Partitioning characteristics of indoor VOCs on impermeable surfaces covered by film-phase DnBP and DEHP, by Zhuo CHEN



In this work, exposed to gaseous VOCs less than 250 ppb, film-phase DnBP and DEHP could capture benzyl alcohol significantly and hexanol slightly from the air, respectively, while toluene was hardly absorbed in the films. This study would contribute to a new understanding of the transformation and fate of film-phase SVOCs and provide film-formation parameters for modelling research.

Zhuo Chen, Qiwei Chen, Ying Xu, Jinhan Mo, 2022. Journal of Hazardous Materials Advances 8, 100191.  
<https://doi.org/10.1016/j.hazadv.2022.100191>



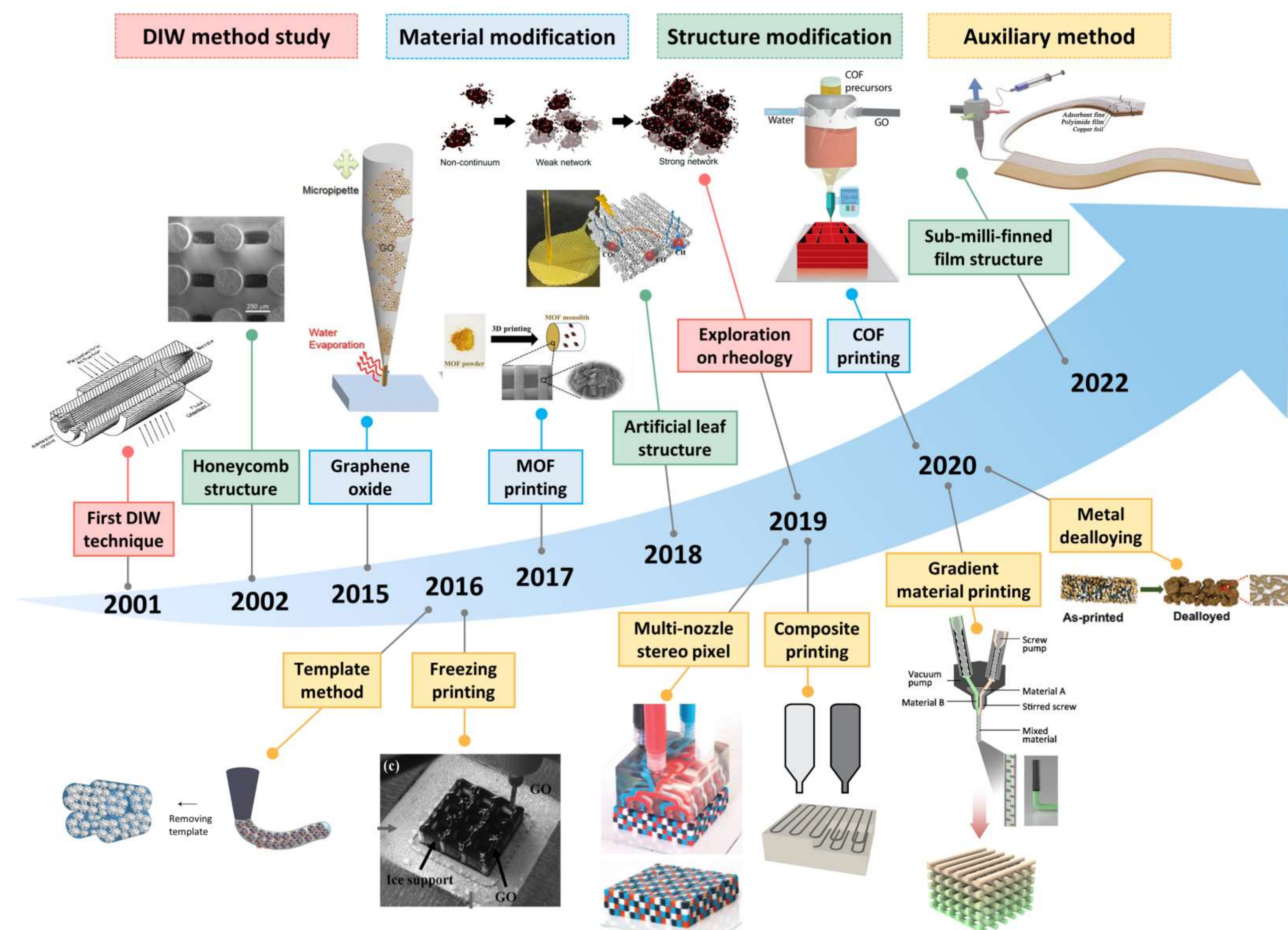
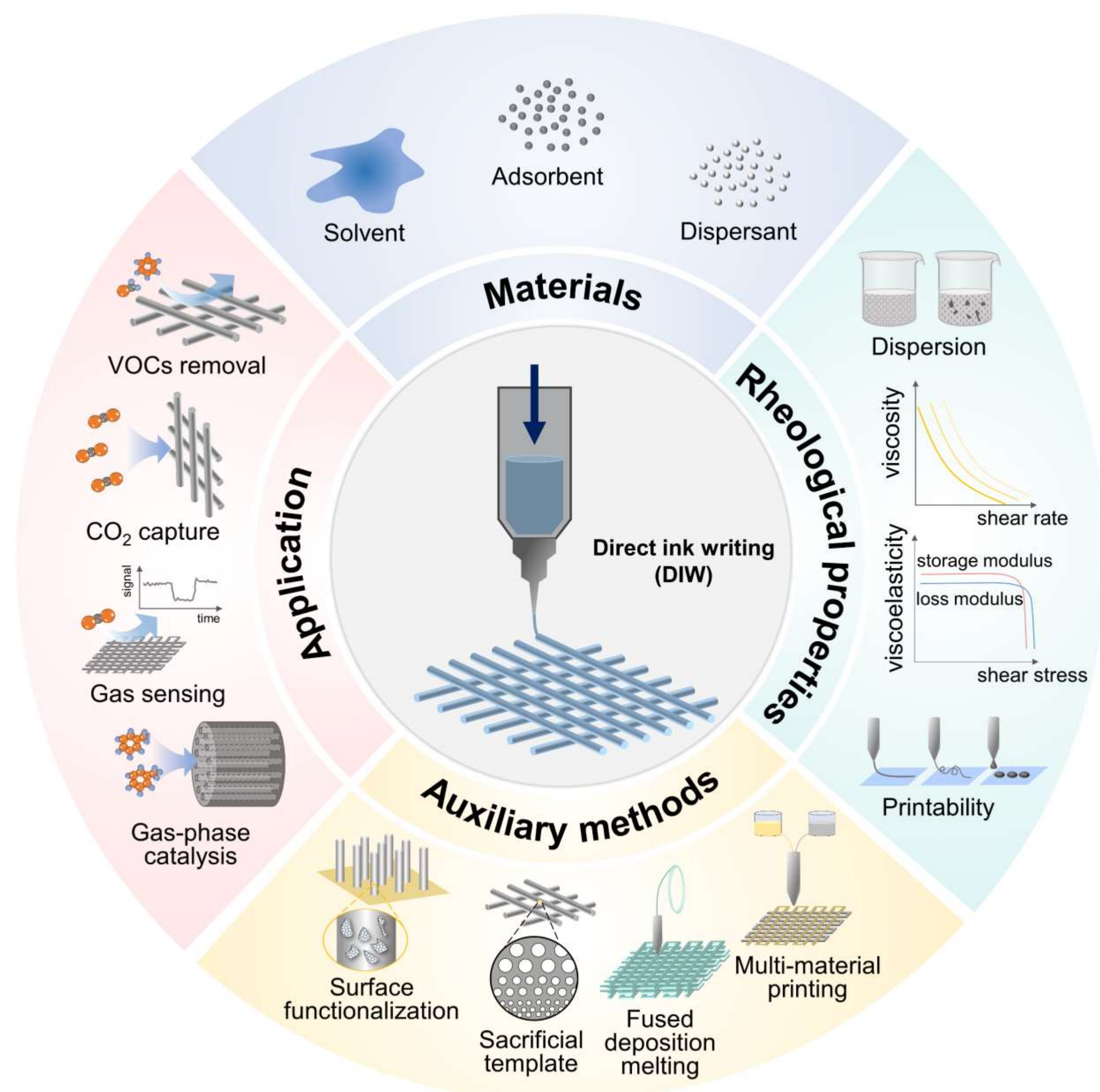


# Research

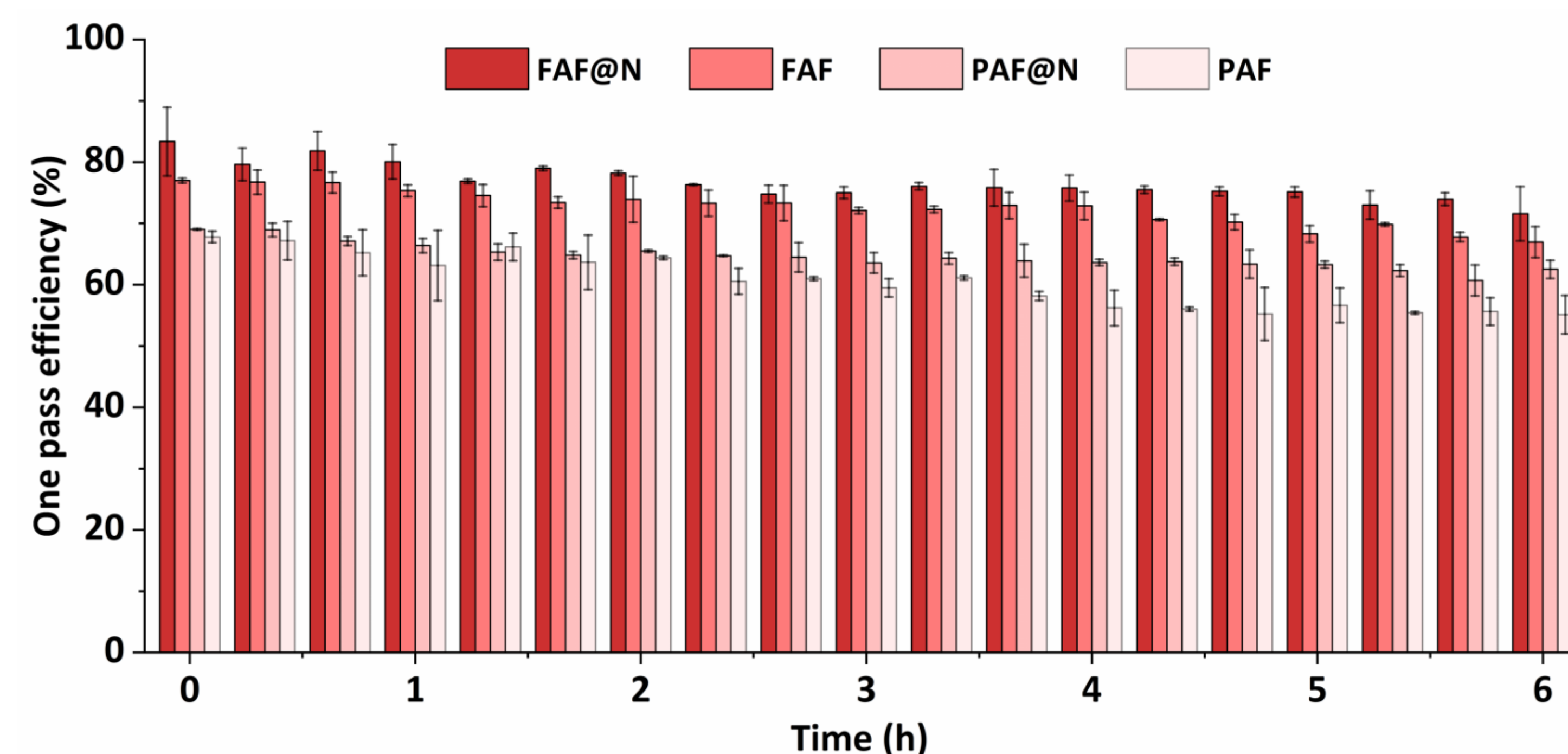
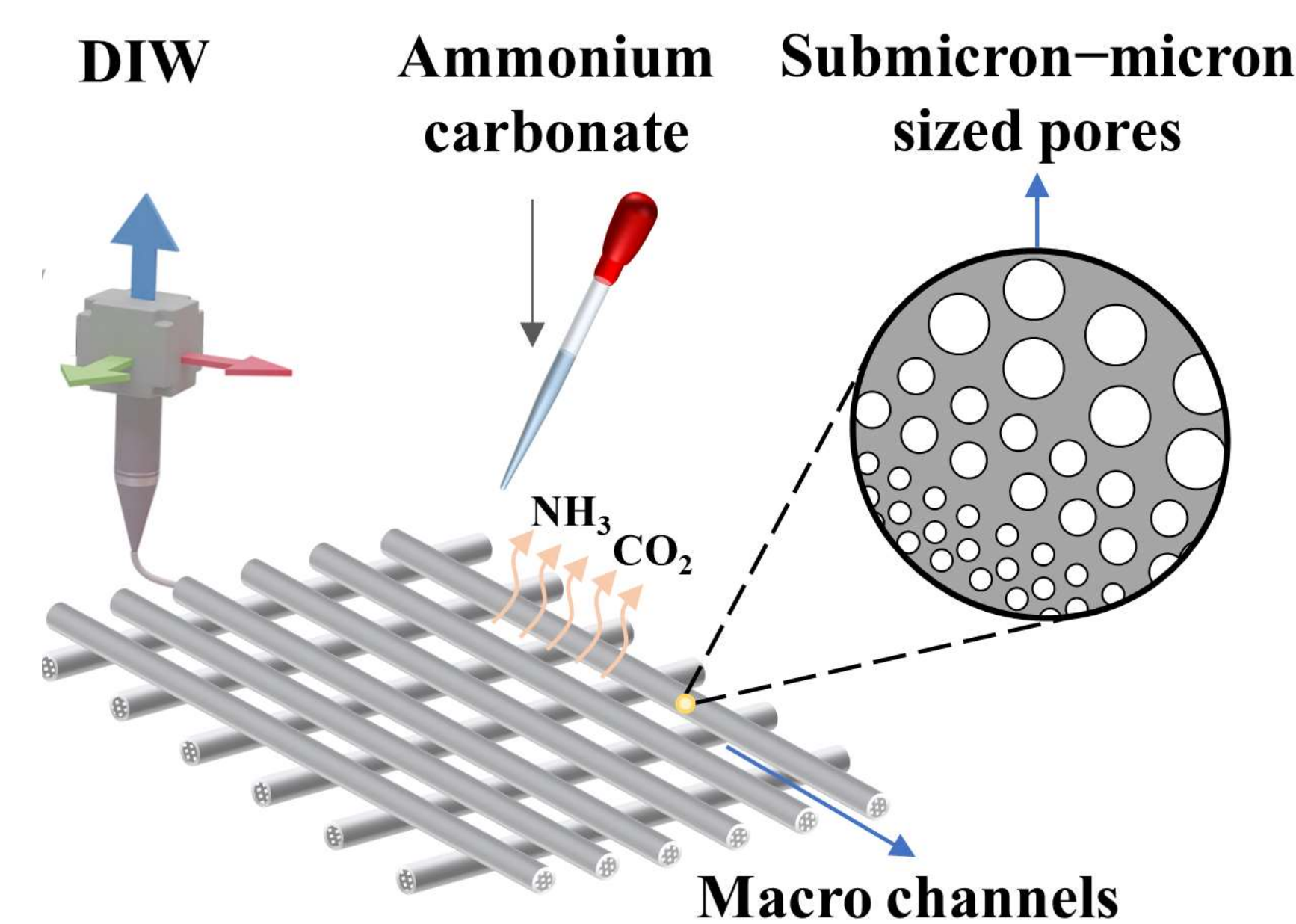
# Activities

# Funs

## Recent progress and perspectives of direct ink writing applications in gas-phase adsorption and catalysis by Qiwei CHEN



- We made a systematic review about the fabrication, application and mass transfer enhancement of direct ink writing (DIW) on the category of adsorption and catalysis.

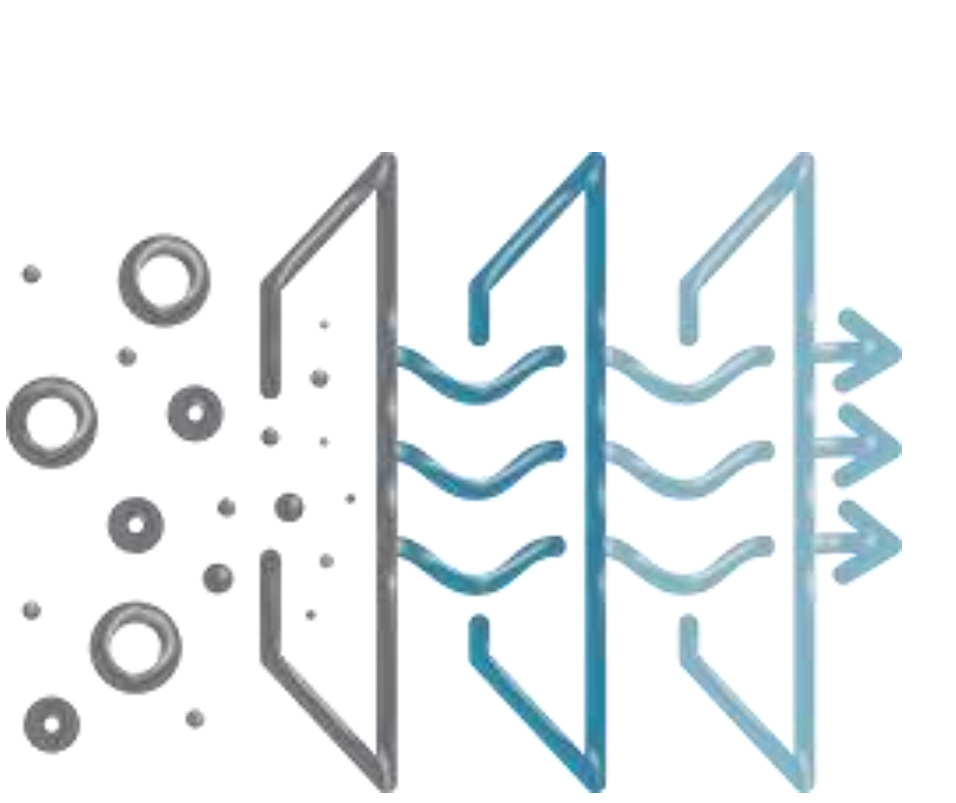


- We fabricated an adsorption film by DIW and used ammonium carbonate processing to form hierarchical porous structures with brilliant formaldehyde removal performance.



Qiwei was practicing archery as a hobby after work

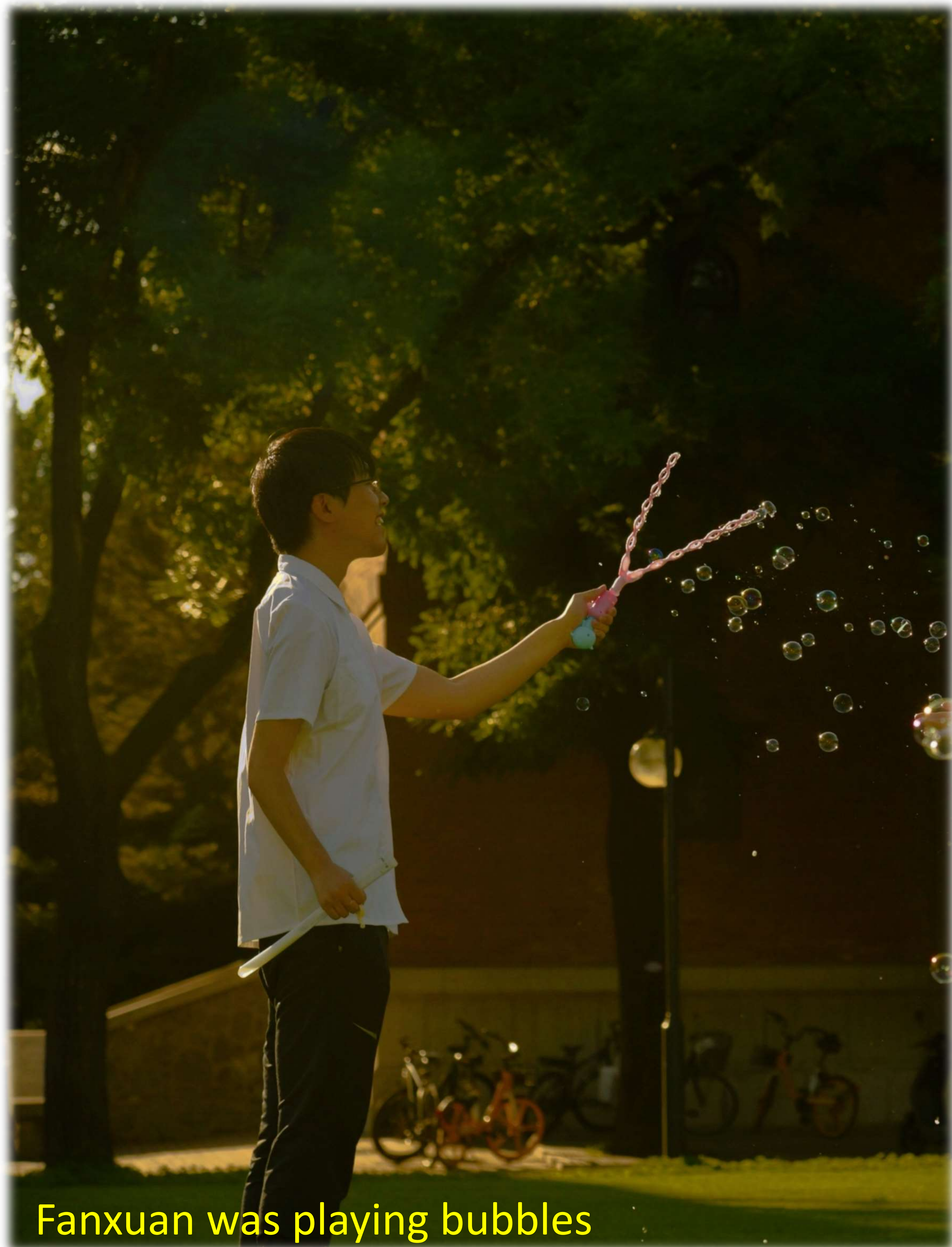




# Research

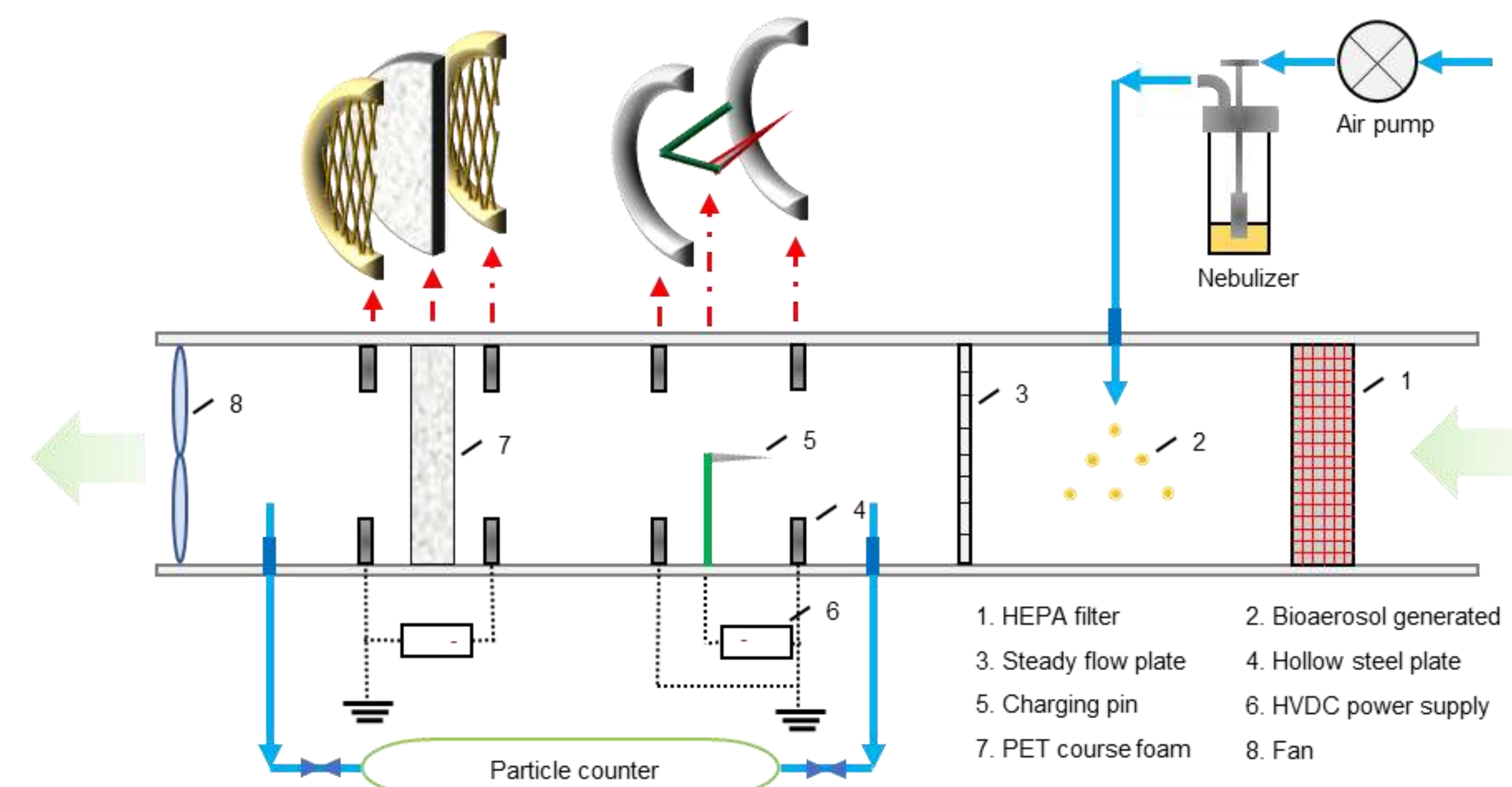
# Activities

# Funs

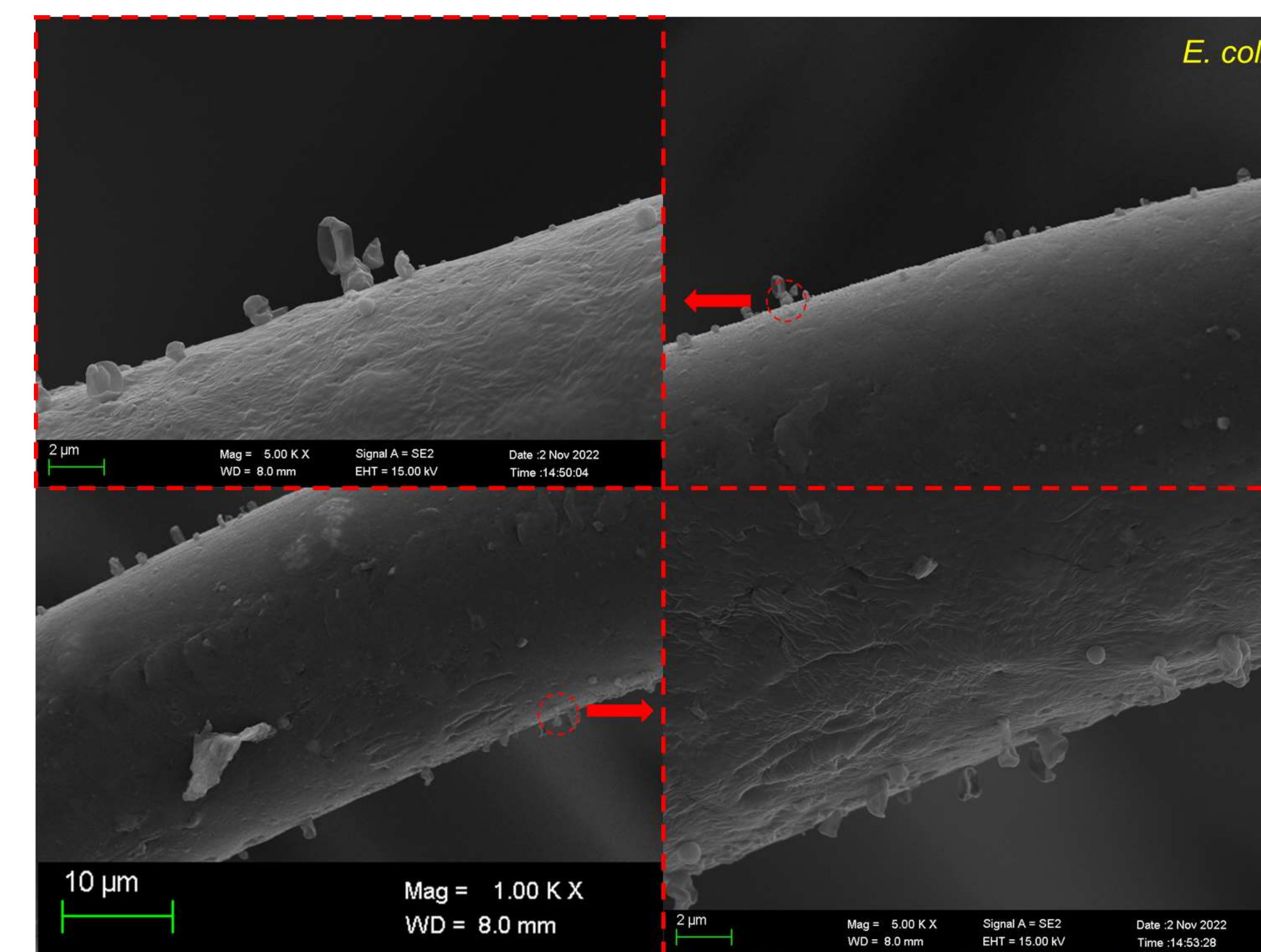
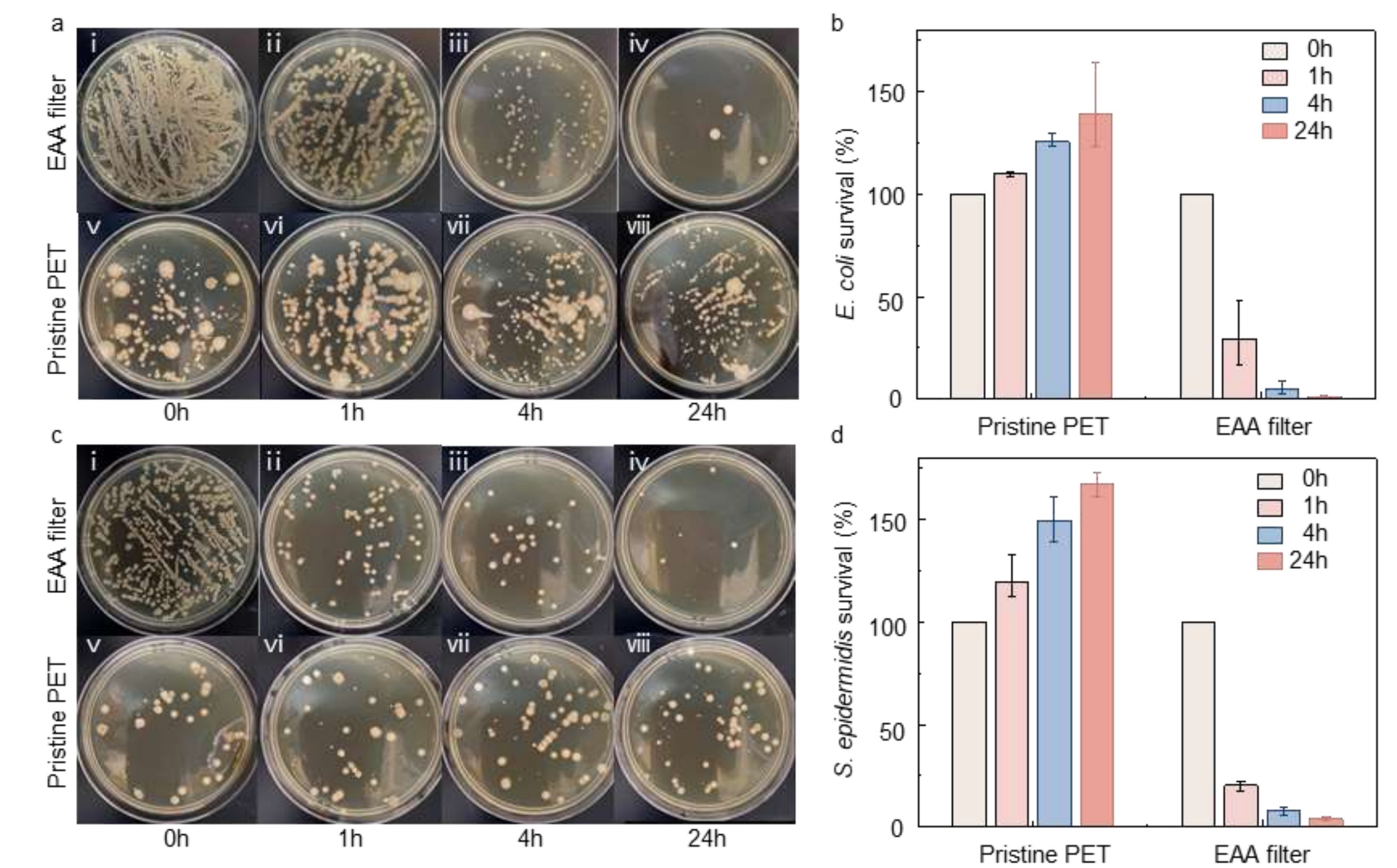


Fanxuan was playing bubbles

## Simultaneous capture and inactivation of airborne bacteria by electrostatically assisted filter by Fanxuan Xia

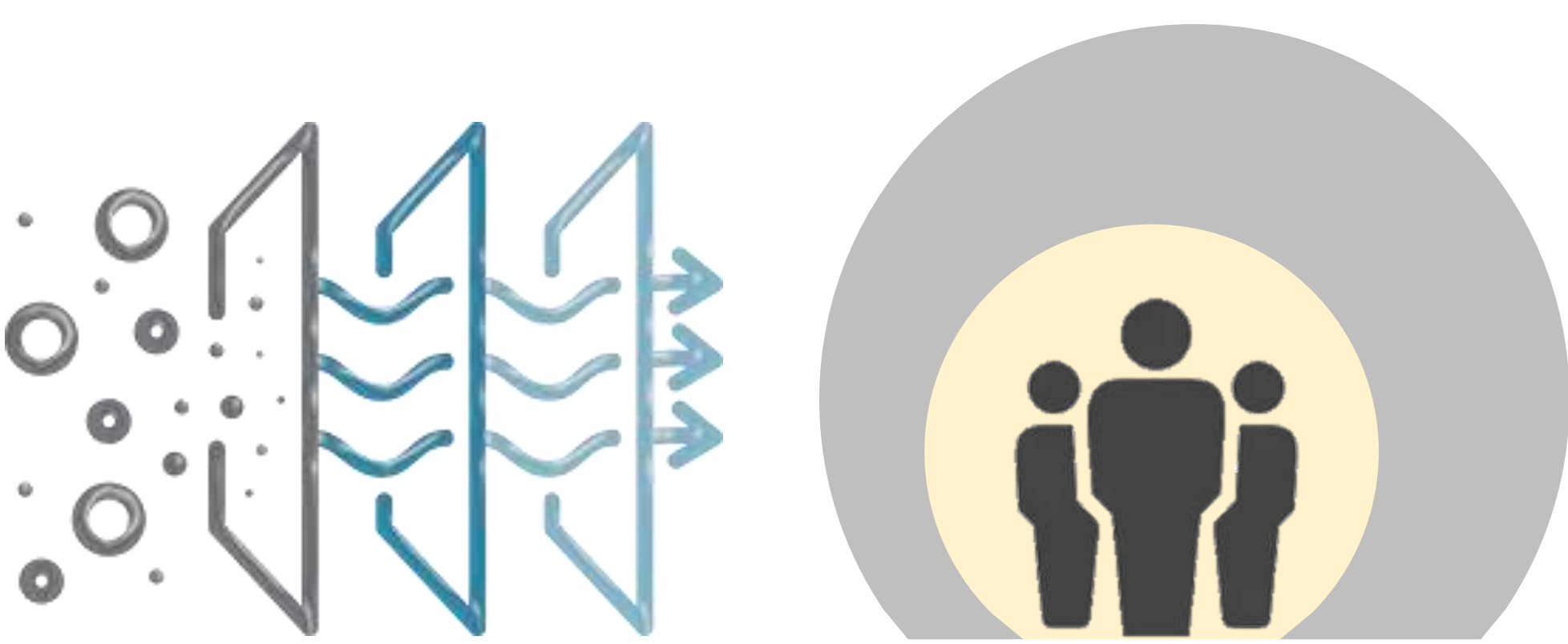


Schematic diagram of the experimental setup

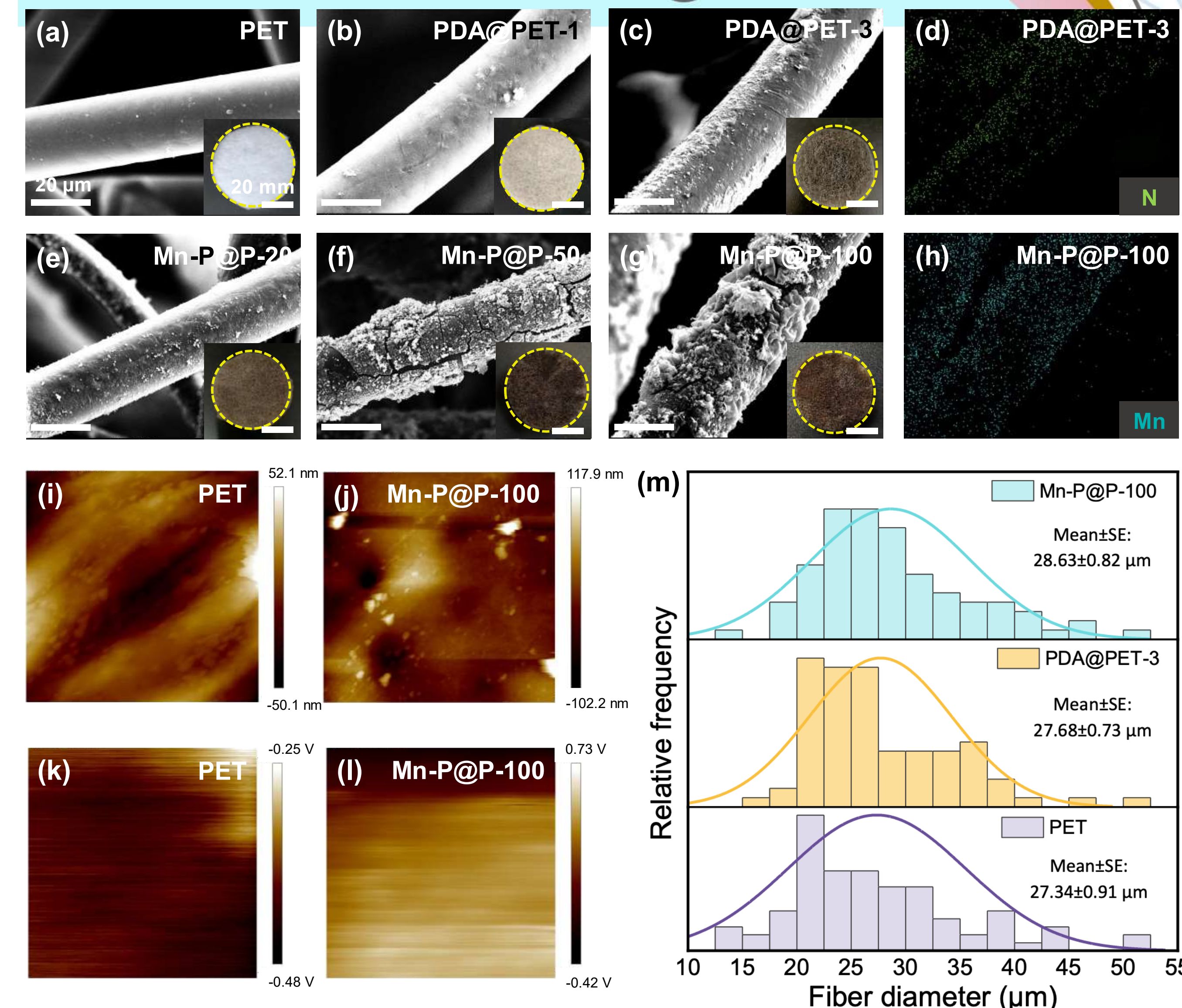
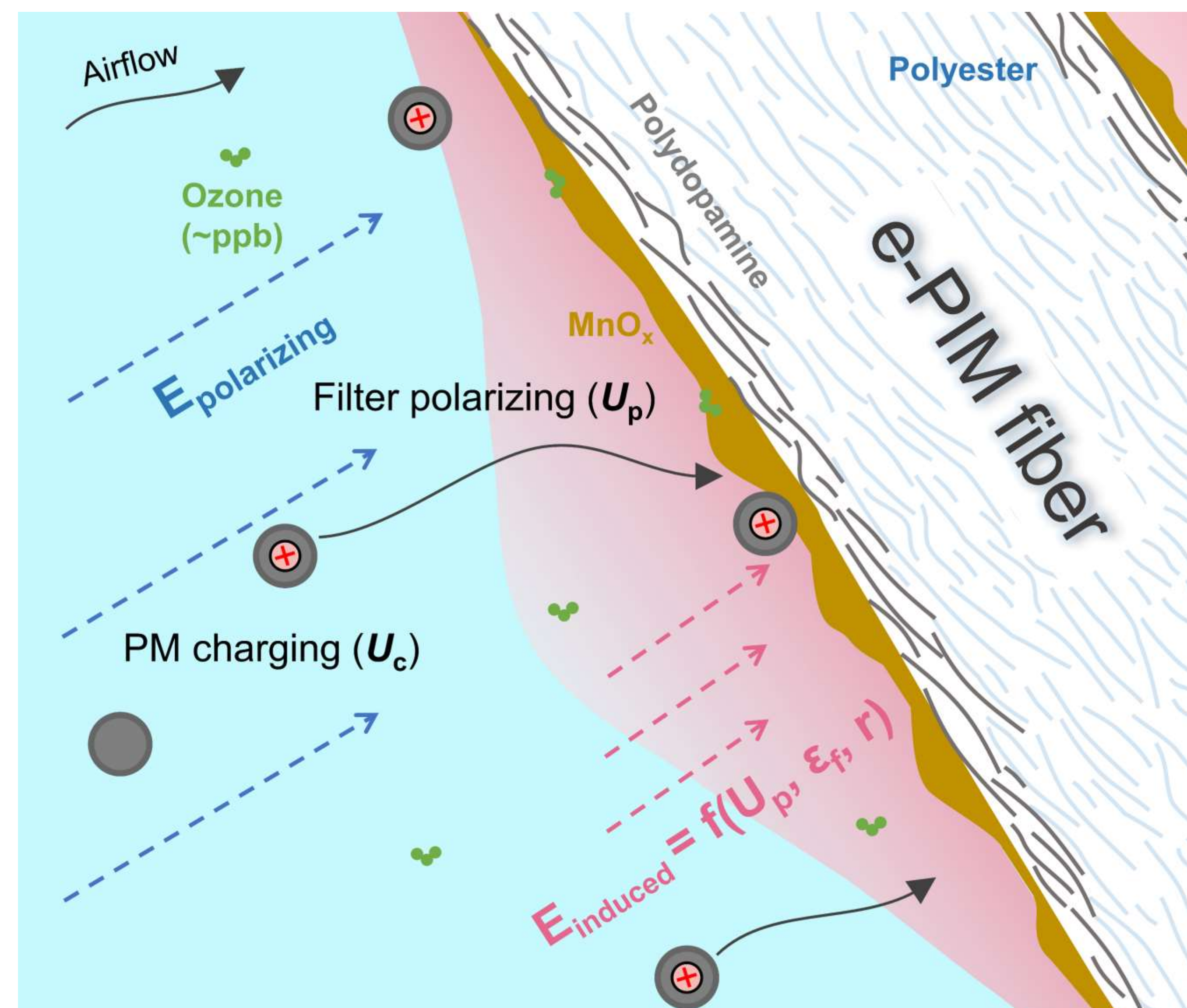


*E. coli* captured and inactivated by the electrostatically assisted filter under SEM





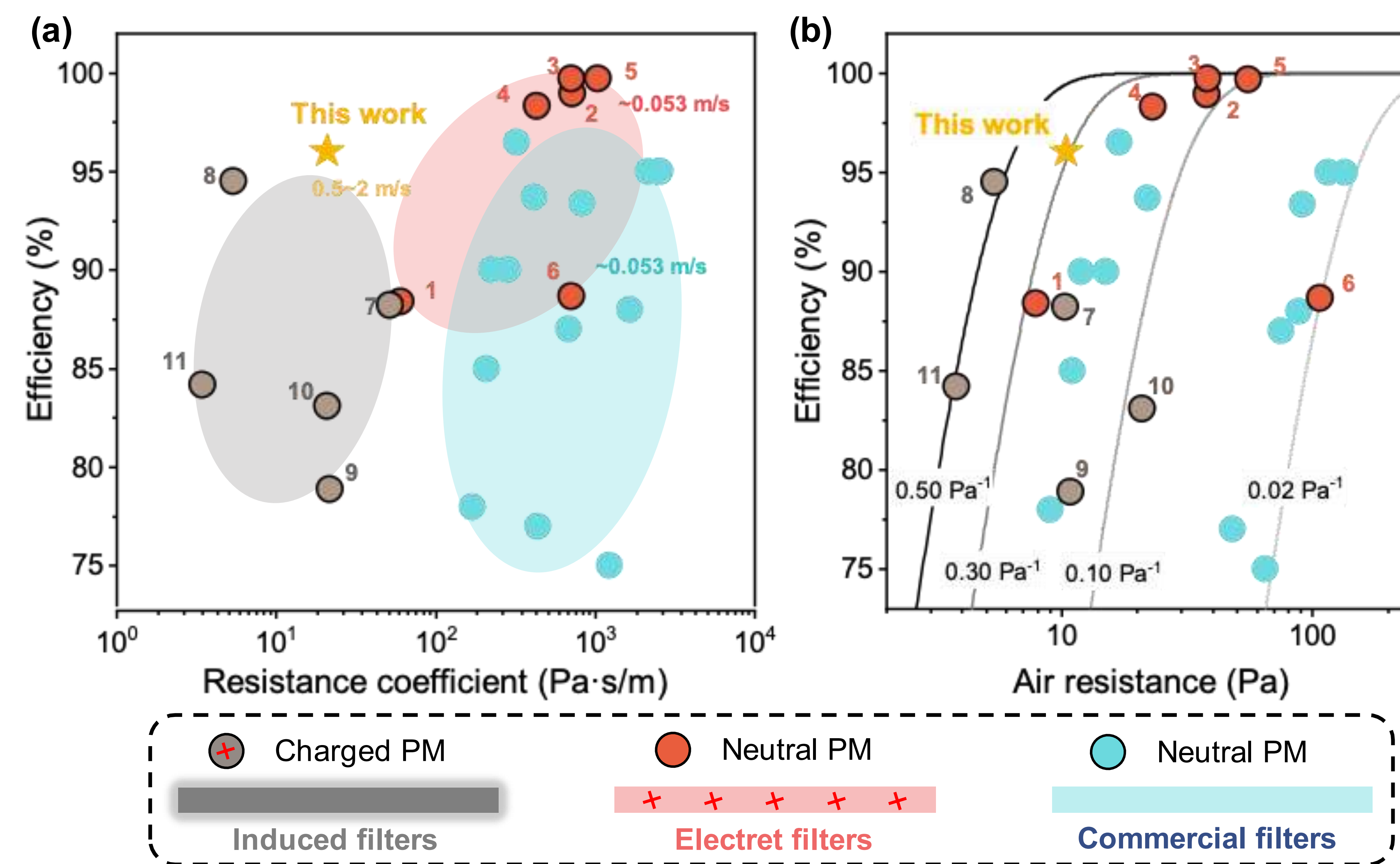
# Research Activities Fun



- An 8-mm-thick e-PIM filter possessed improved efficiency of 96.05%, 97.60%, and 99.14% for 0.3–0.5  $\mu\text{m}$ , 0.5–1  $\mu\text{m}$ , and 1–3  $\mu\text{m}$  particles, the ultralow air resistance of 10.4 Pa at a filtration velocity of 0.5 m/s, and steady ozone removal efficiency of 96.8%.

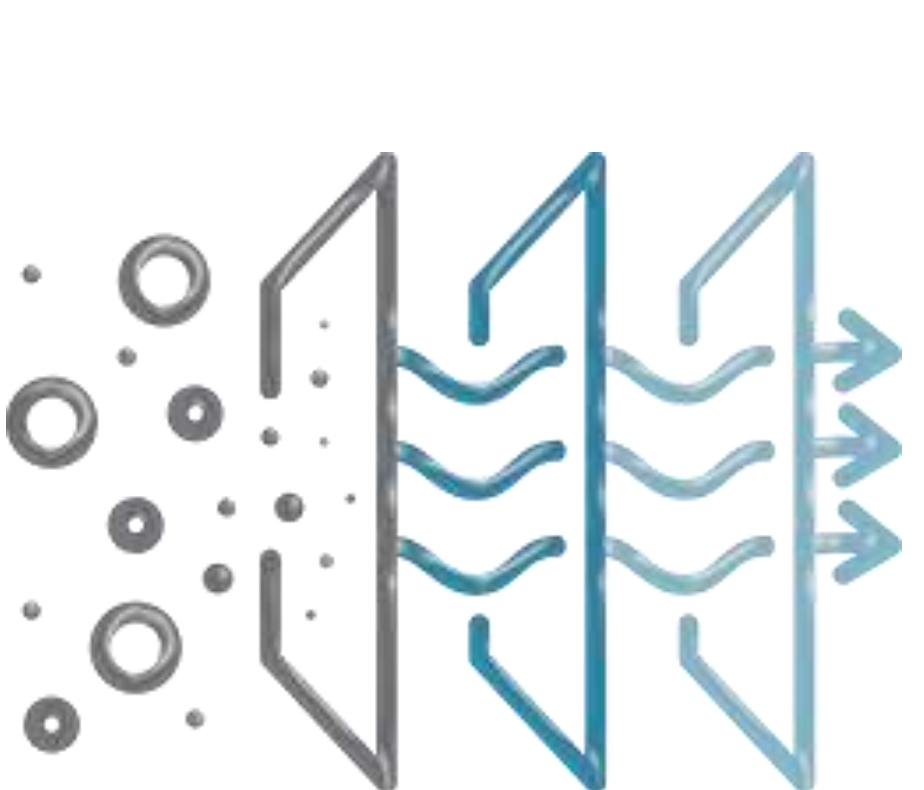
## e-PIM filters with tuned surface properties for particle and ozone removal by Yilun Gao, Enze Tian and Jinhan mo

- We introduced an electrostatic polydopamine-interface-mediated (e- PIM) filter utilizing a combined effect of particle pre-charging and filter polarizing. The surface topography of polyester (PET) coarse substrates were regulated by successively coating polydopamine (PDA) layers and manganese oxide clusters.
- Gao YL, Tian EZ\*, Mo JH\*, Journal of Hazardous Materials, 2023, 441: 129821. <https://doi.org/10.1016/j.jhazmat.2022.129821>



Yilun was looking at the blackboard in an onsite lecture.



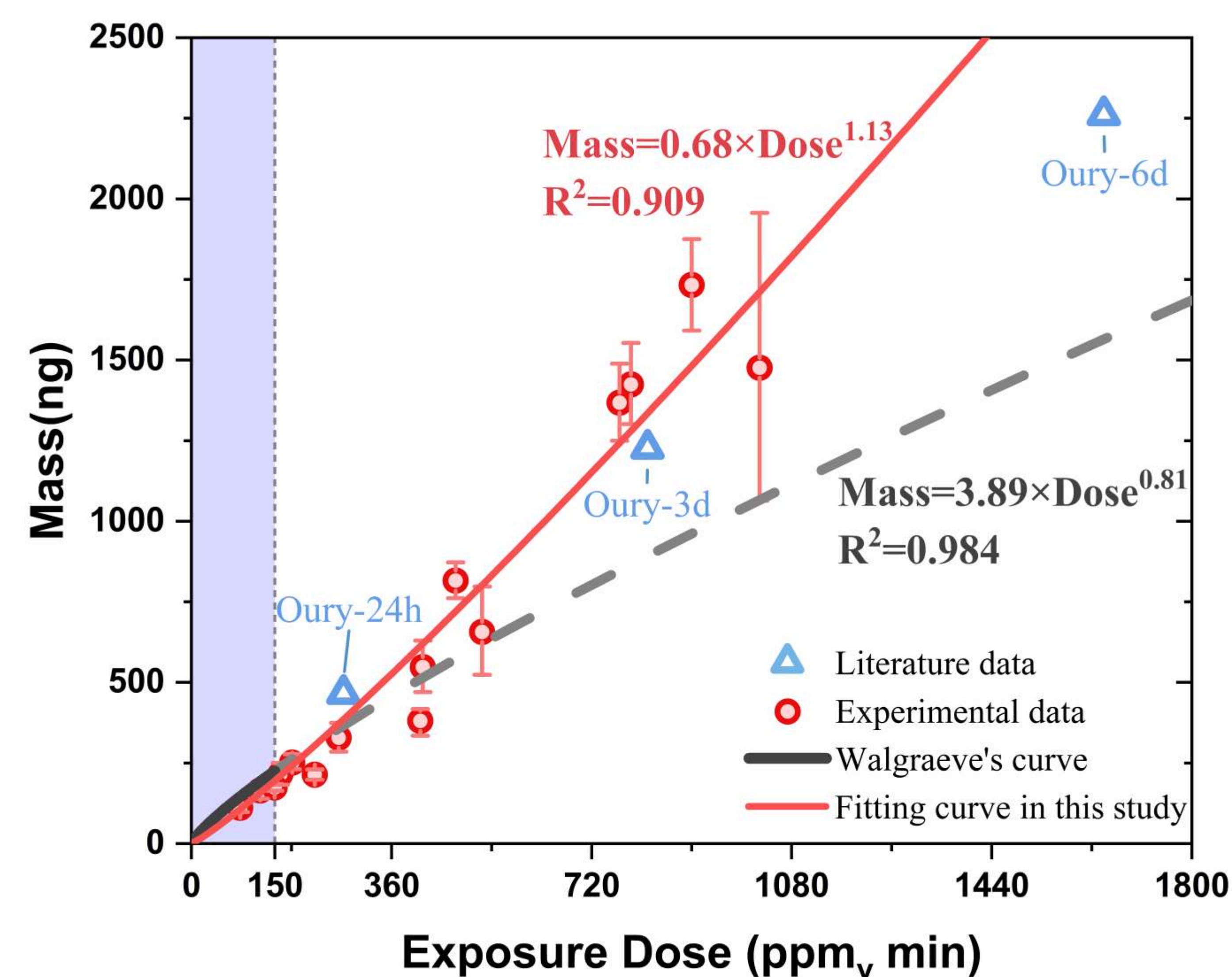
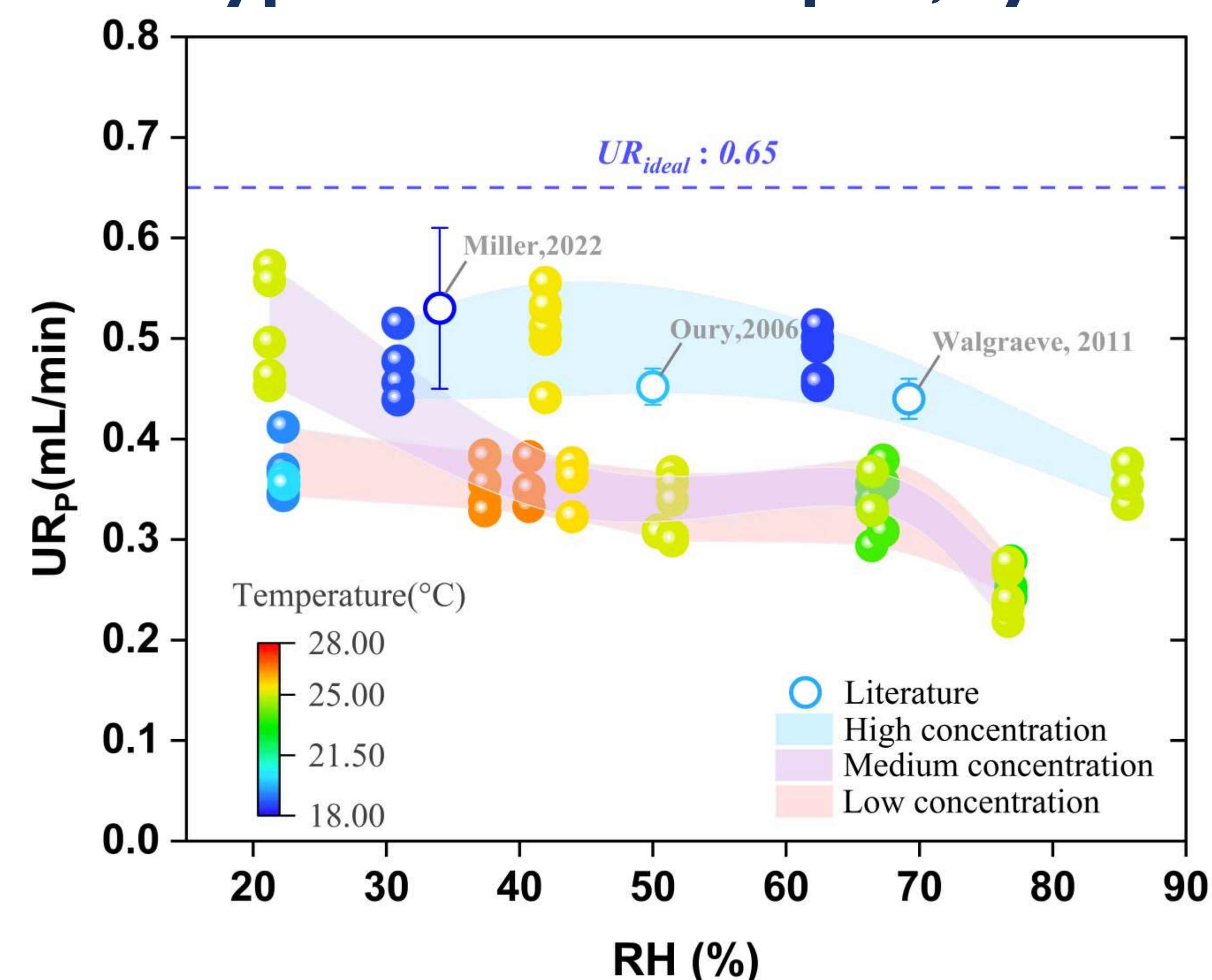


# Research

# Activities

# Fun

## The influence of indoor environmental factors on toluene uptake rate of a tube-type diffusive sampler, by Yan WANG

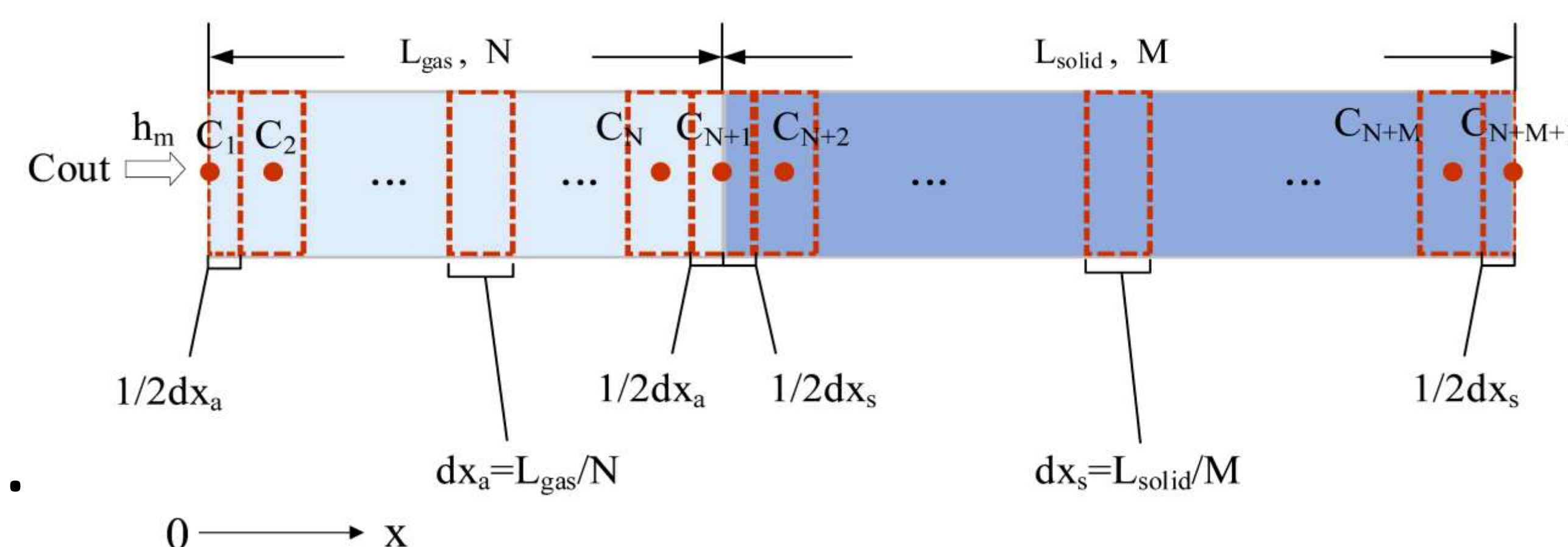


In this study, we explore the influence of environmental factors (temperature, humidity and concentration) on the 24h uptake rate of toluene in Tenax TA diffusive samplers. Regression equation was proposed to predict the 24h toluene uptake rate at various environmental factors.

Yan Wang, Tao Yu, Jinhan Mo, The influence of indoor environmental factors on toluene uptake rate of a tube-type diffusive sampler, Journal of Building Engineering, 54, 2022, 104587. <https://doi.org/10.1016/j.jobe.2022.104587>.

## Prediction and validation of diffusive uptake rates for indoor volatile organic compounds in axial passive samplers

In this study, a diffusive uptake rate prediction model is established for a wide range of VOCs. We provide a reliable numerical method to calculate the diffusive uptake rate of VOCs.

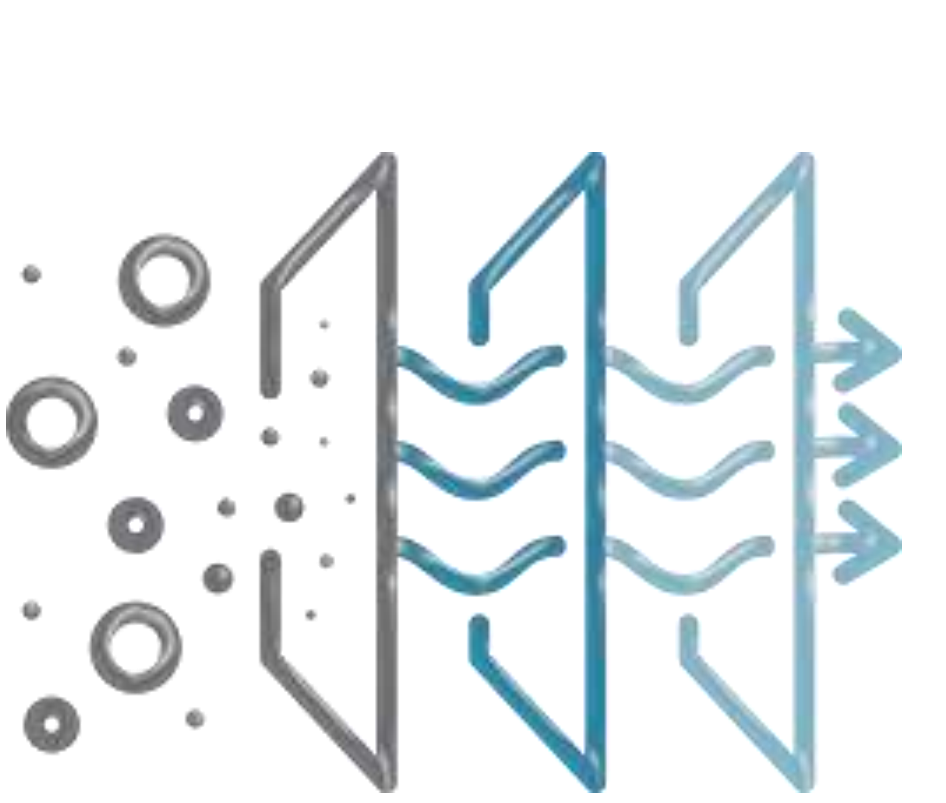


Yan Wang, Tao Yu, Jinhan Mo, The influence of indoor environmental factors on toluene uptake rate of a tube-type diffusive sampler, Journal of Building Engineering, 54, 2022, 104587. <https://doi.org/10.1016/j.jobe.2022.104587>.



Yan volunteered for the 2022 Winter Olympics in Beijing





# Research

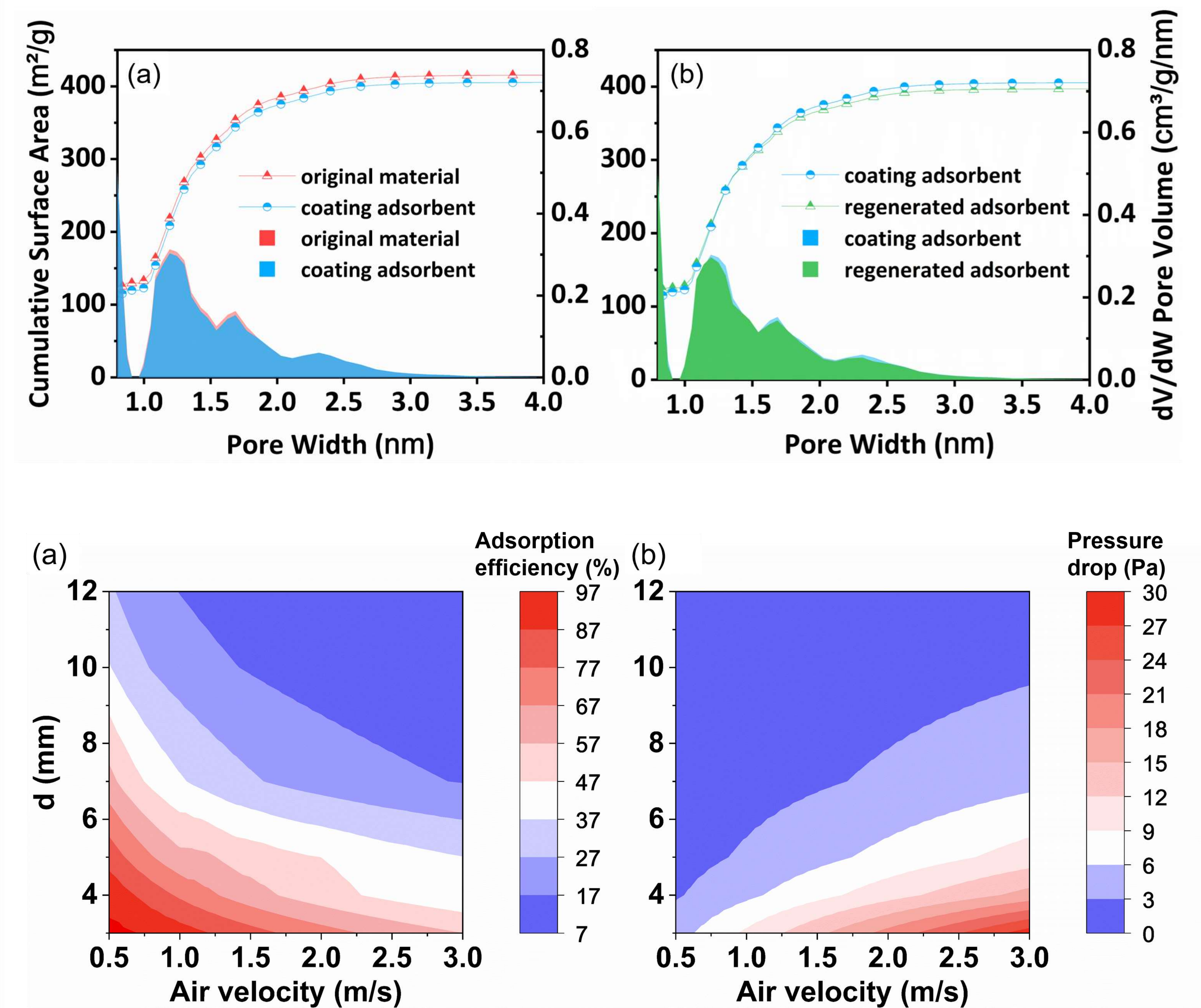
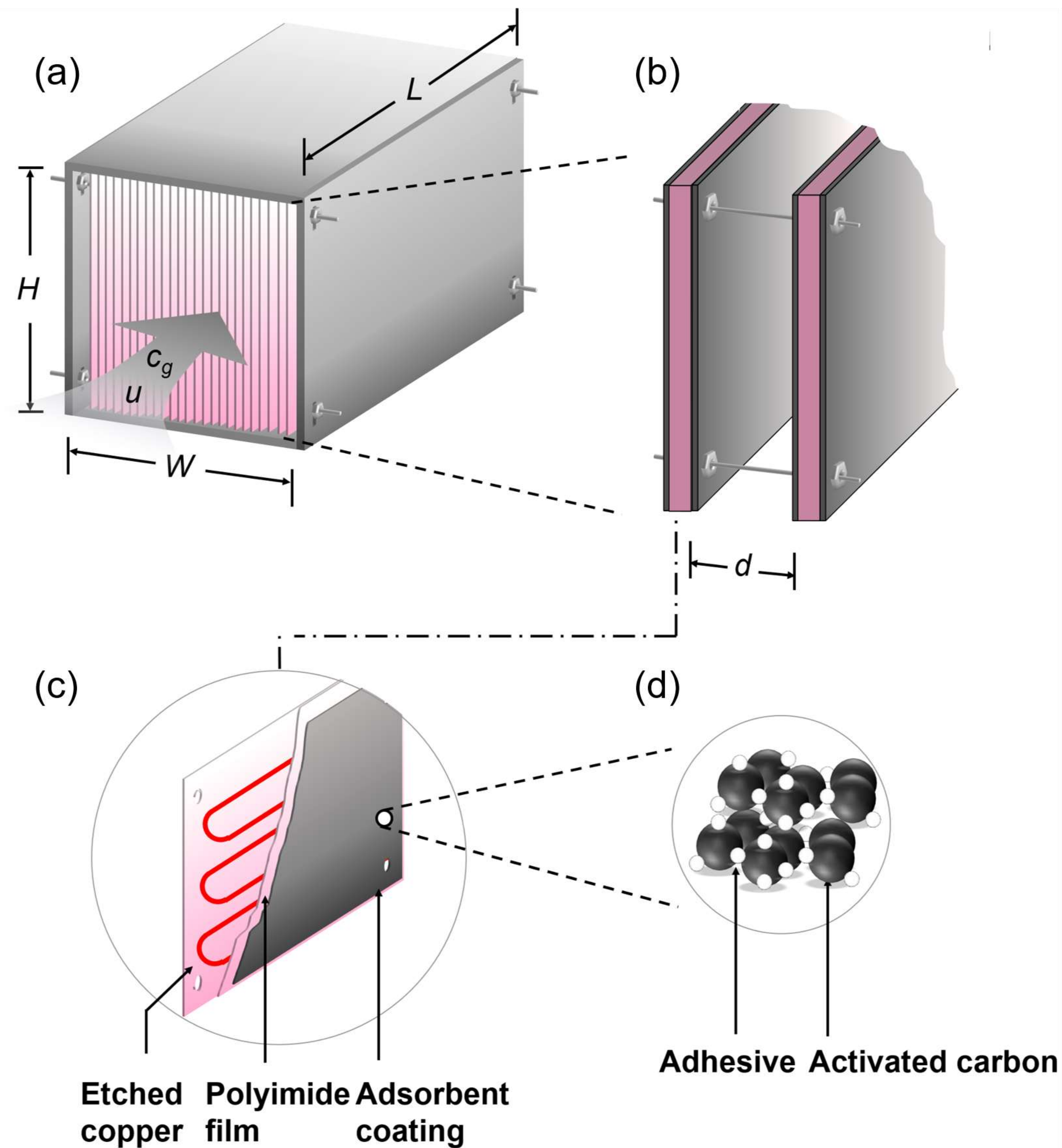
# Activities

# Funs

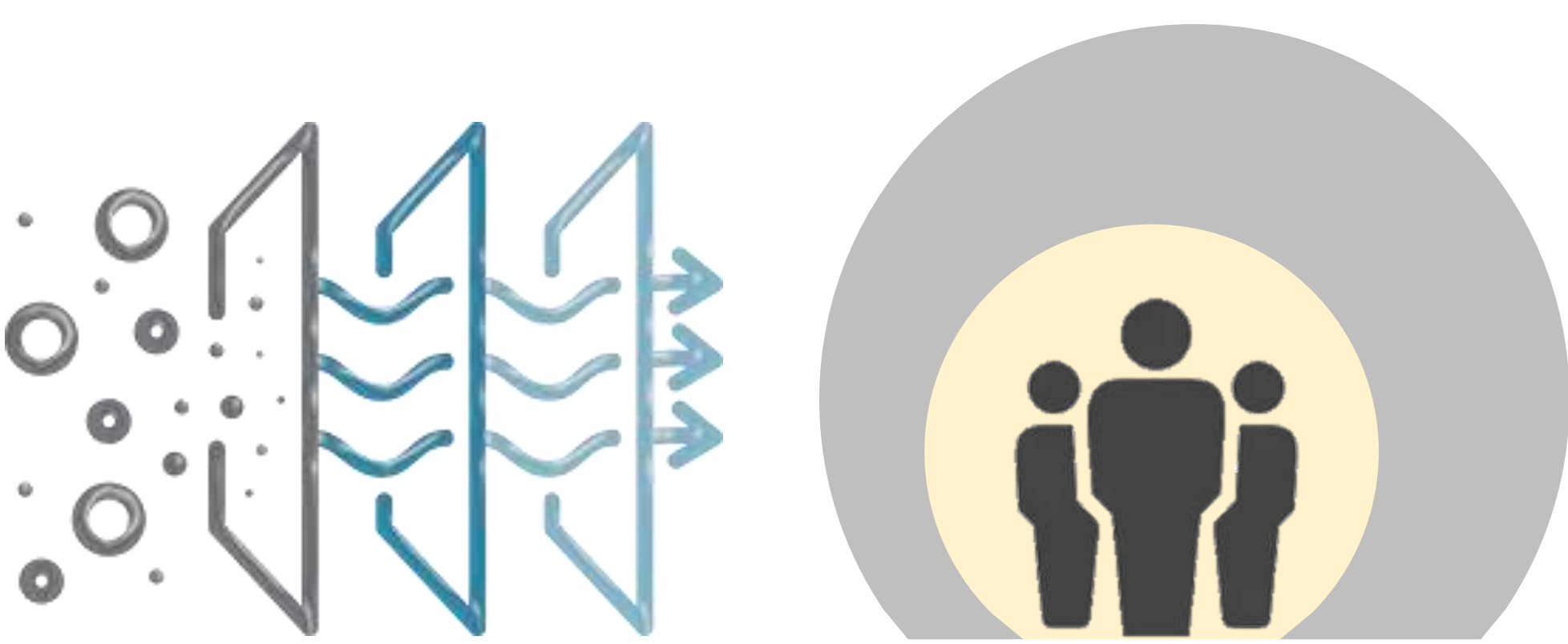
## Modelling and Implementation of an In-situ Thermally Regenerated Adsorption Module for Removing Gaseous Xylene, by Xiao LEI



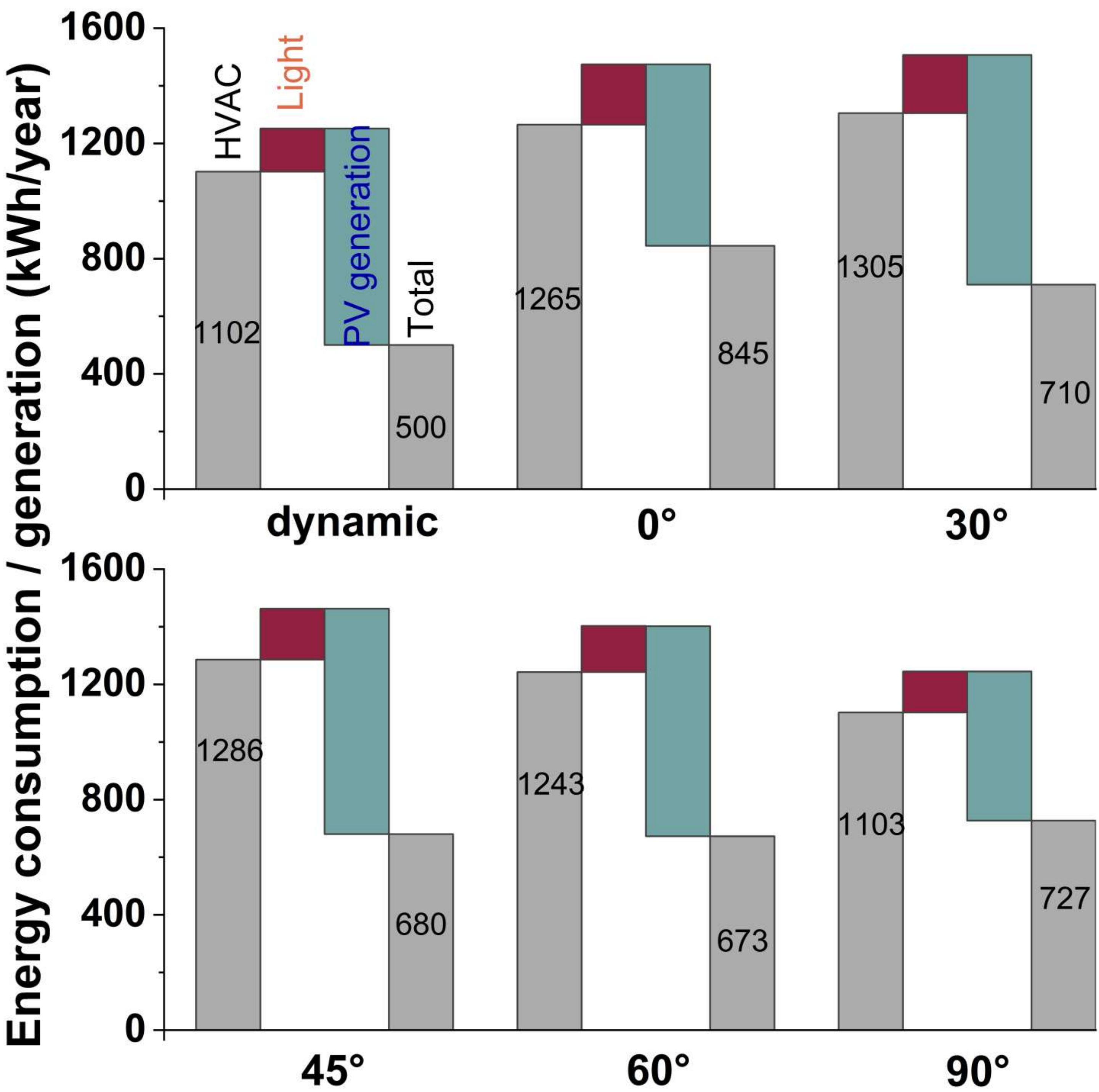
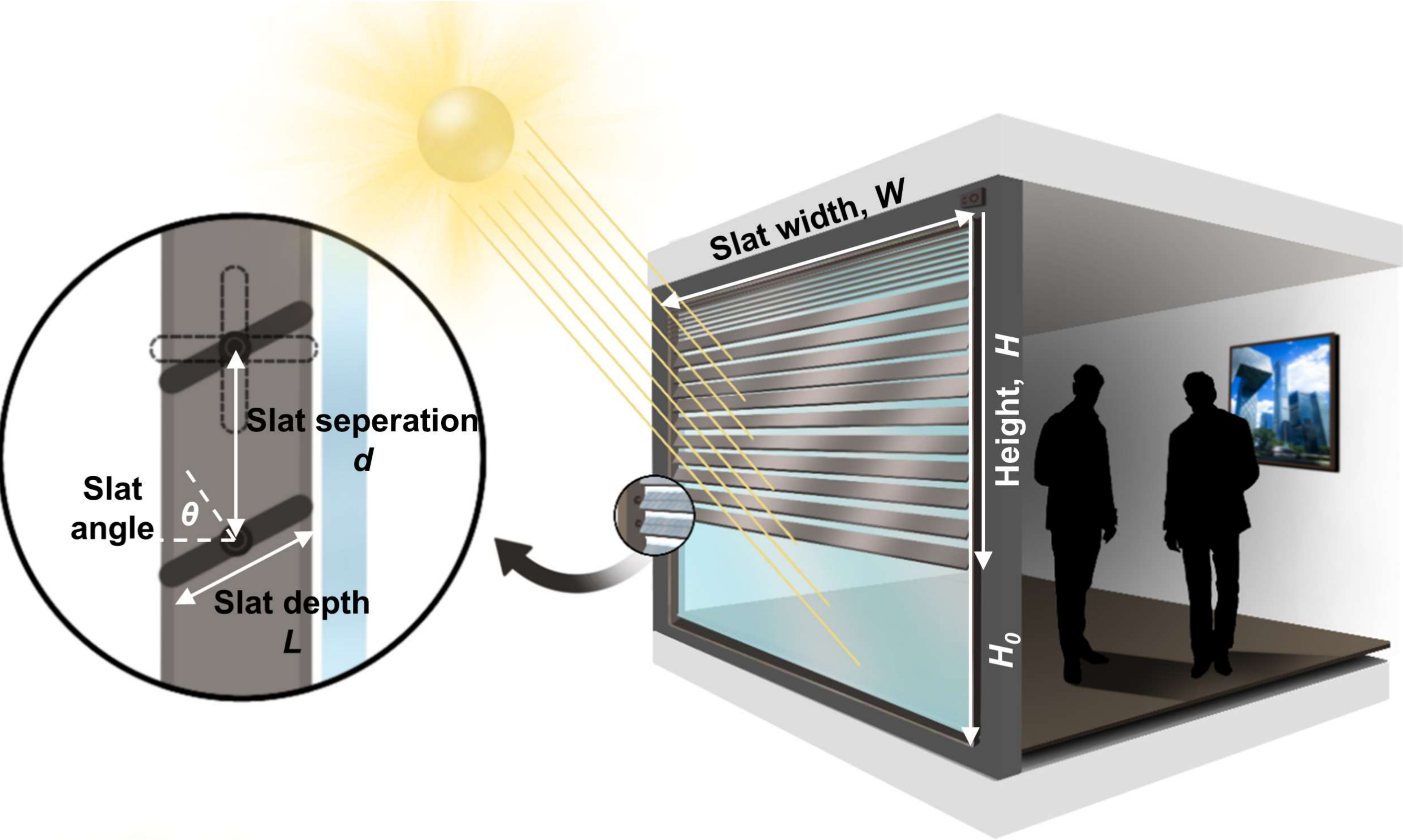
Lei Xiao is conducting field tests at the furniture factory.







A smart dynamic blind integrated with PV cells, by Wuwei ZOU

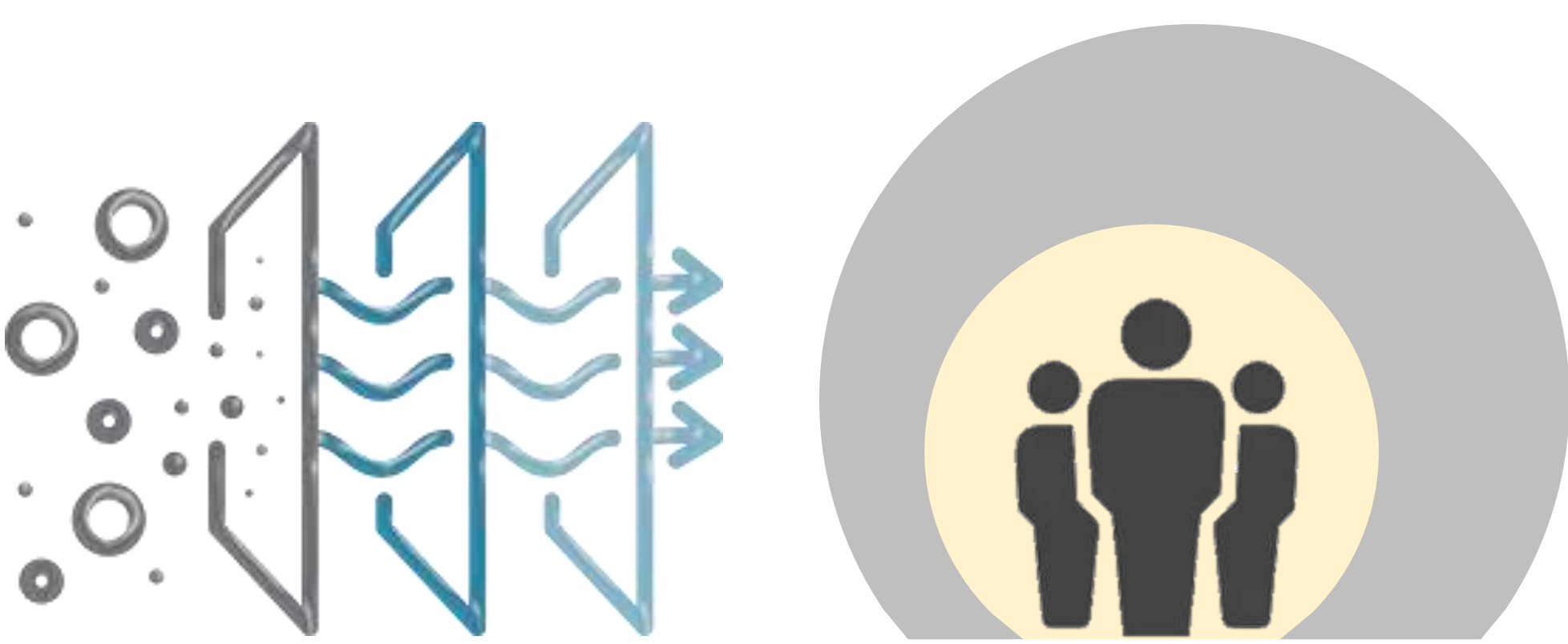


We propose a dynamic and vertical photovoltaic integrated shading device (dvPVSD), which is weather-responsive and can effectively regulate passive heating, daylight penetration, and energy generation. The simulation result of the dynamic PV blind shows great potential in energy savings and carbon emission reduction compared to static PV blinds.



Wuwei Zou enjoyed a good time with a polar bear.



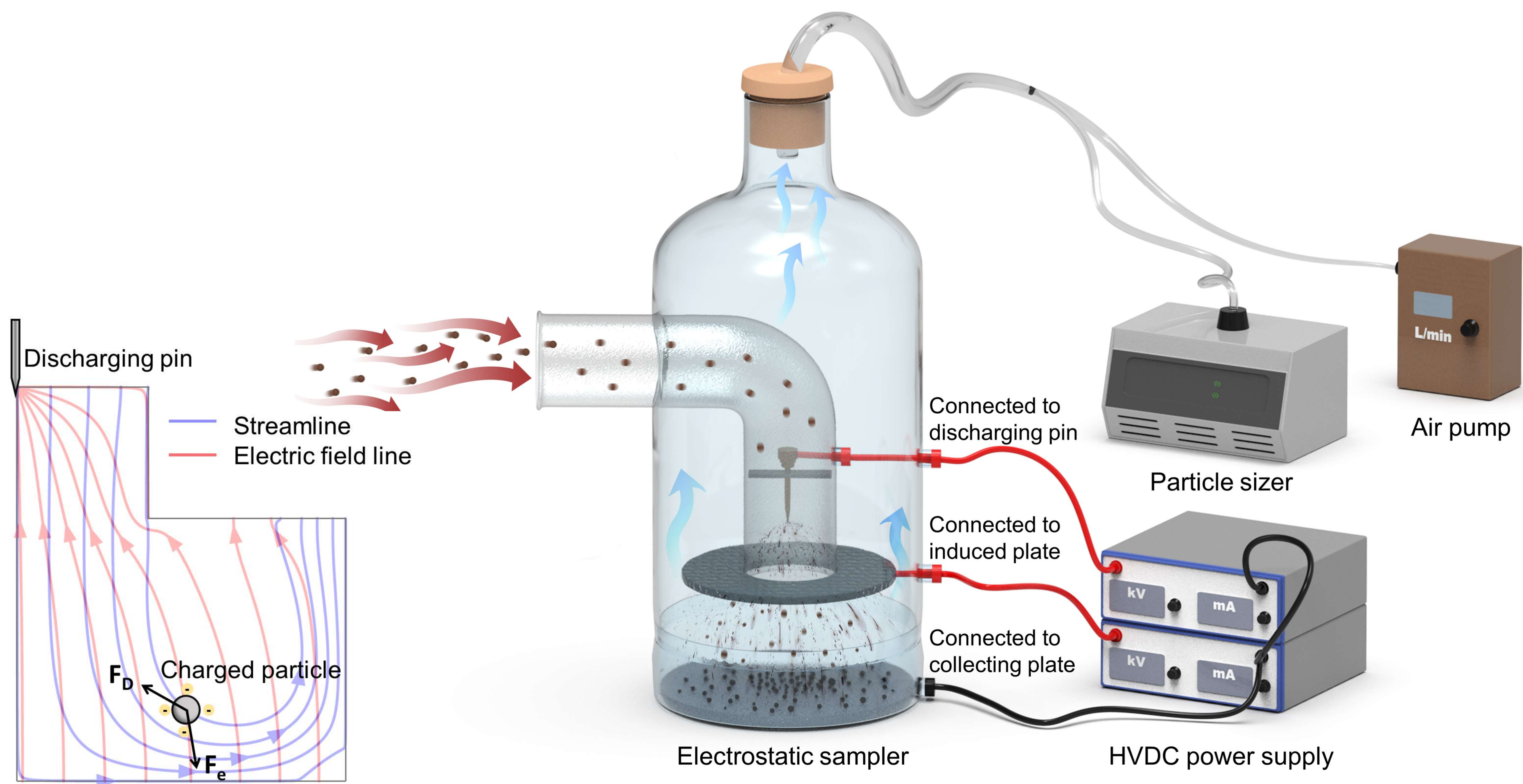


# Research

# Activities

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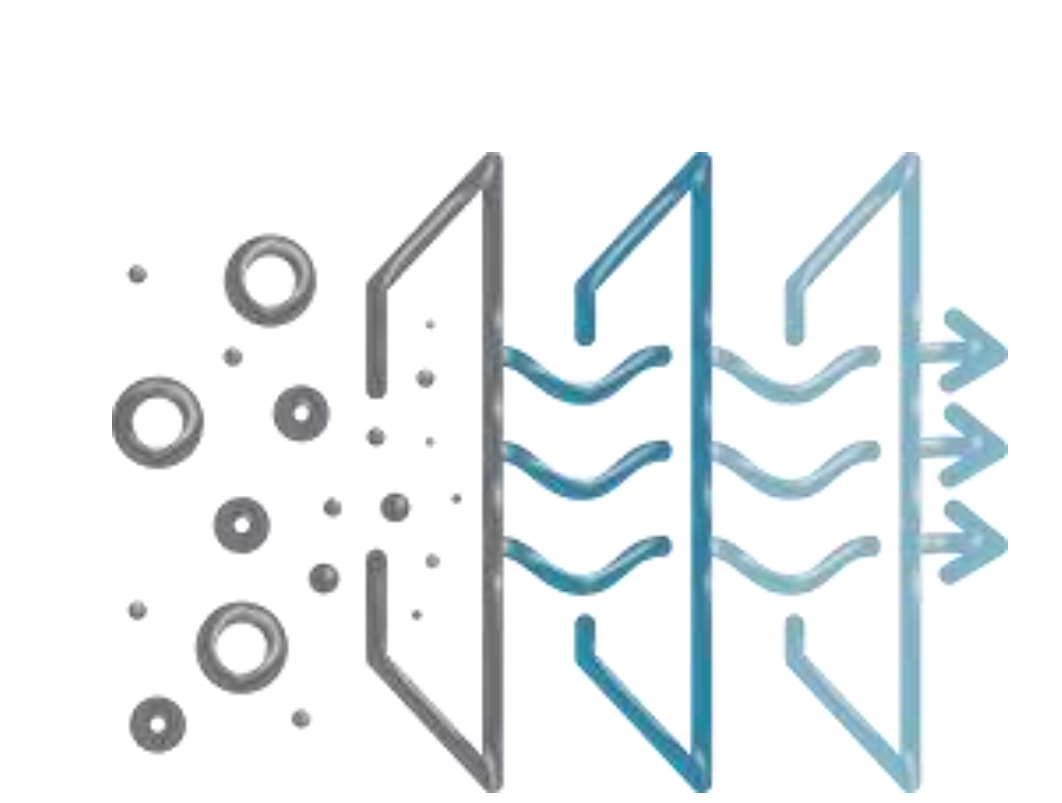
## Design of a novel miniaturized electrostatic sampler for efficient airborne particle matter sampling, by Xihui LIU



Xihui and her first tour in Beijing

This study developed an electrostatic sampler based on corona discharge and a modified vertically focused electric field. The intercoupling physical fields were analyzed by simulation.





# Research

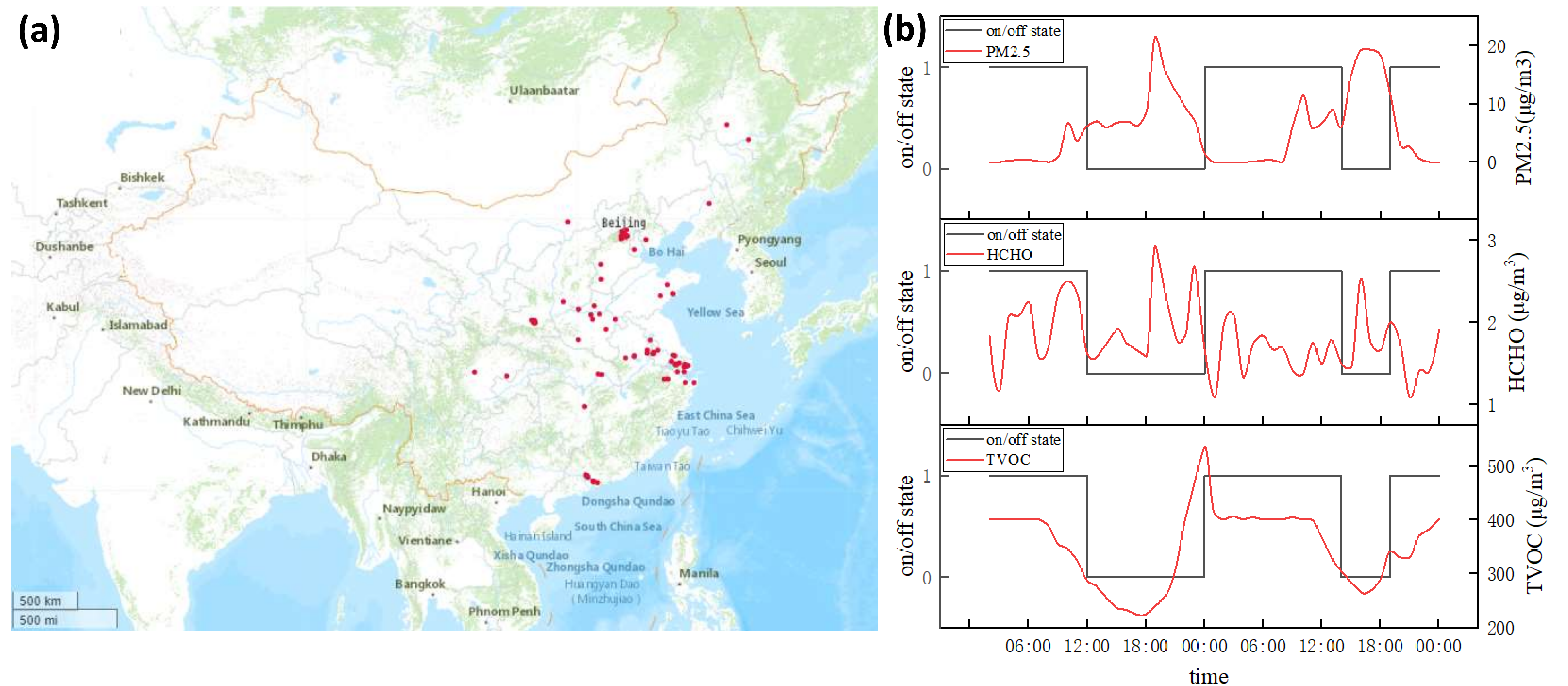
# Activities

# Fun



Jiaze traveled in Xiamen city, thinking that he would look handsome without showing his face.

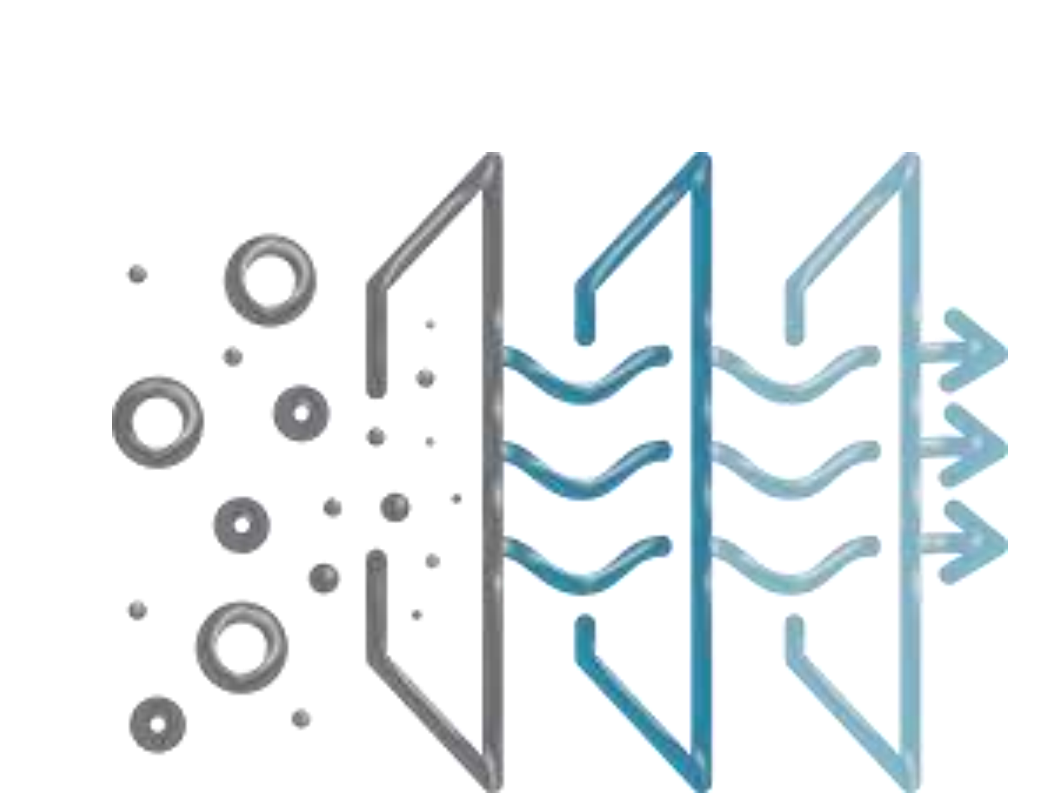
**Study for a three-year dataset of hourly air state parameters from 100 air purifiers installed in China residential buildings, Jiaze WEI**



(a) Distribution of 100 air purifiers in China

(b) Changes in air state parameters over two days

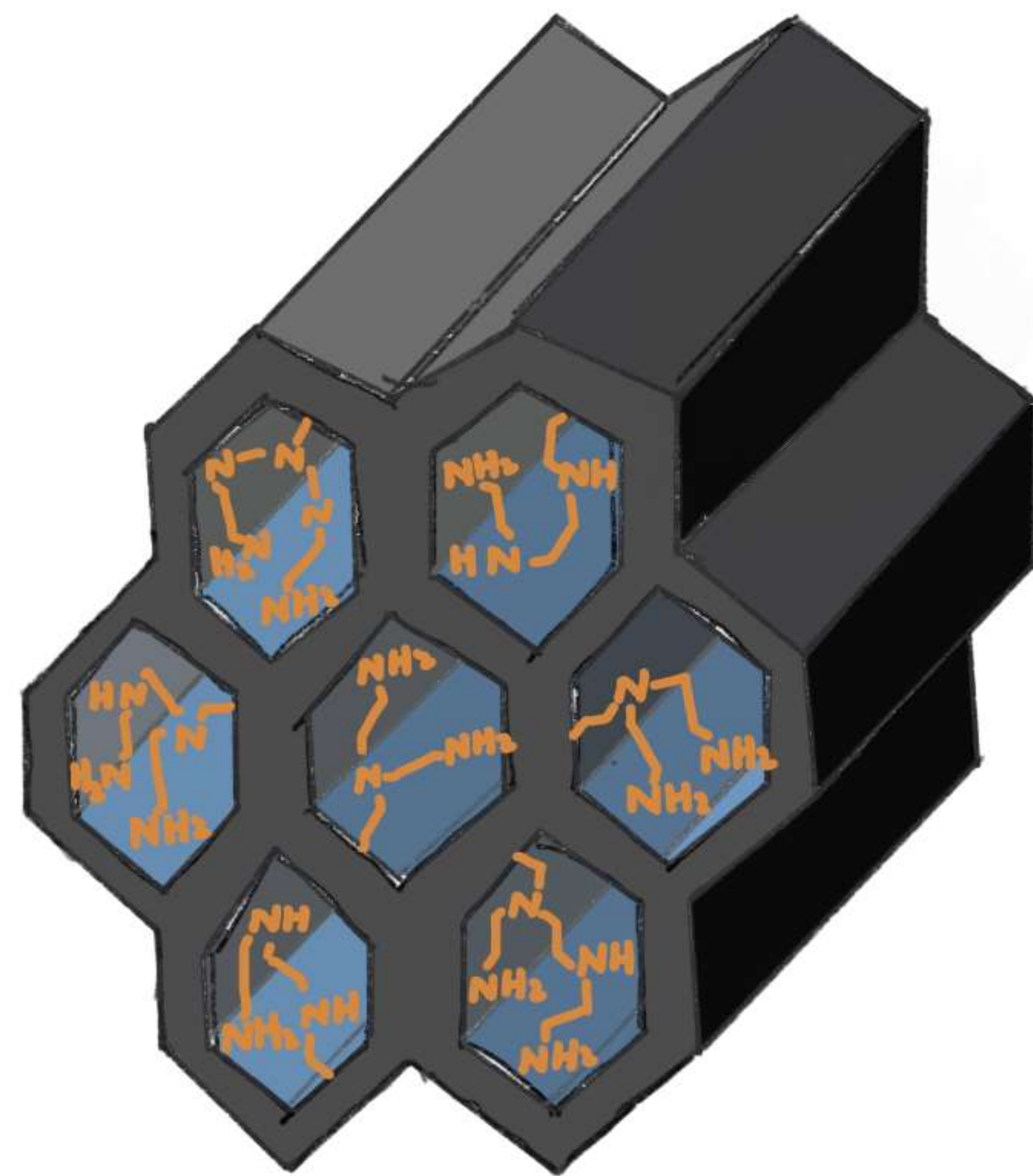




# Research

# Activities

# Fun

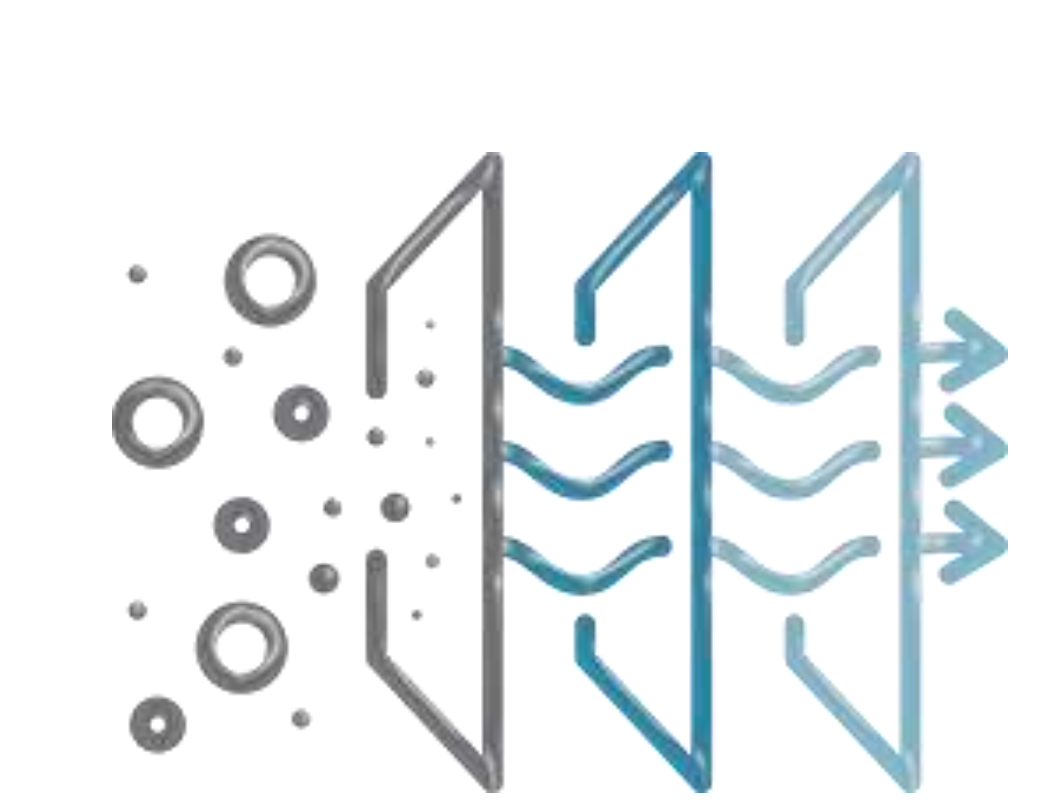


Ziyi is starting to research mass transfer enhancement and amine-modified methods of porous carbons to improve its uptake of low concentration CO<sub>2</sub>.



**Ziyi LUO from Tsinghua University will join our team for her Ph.D. study on Sept. 2023**





# Research

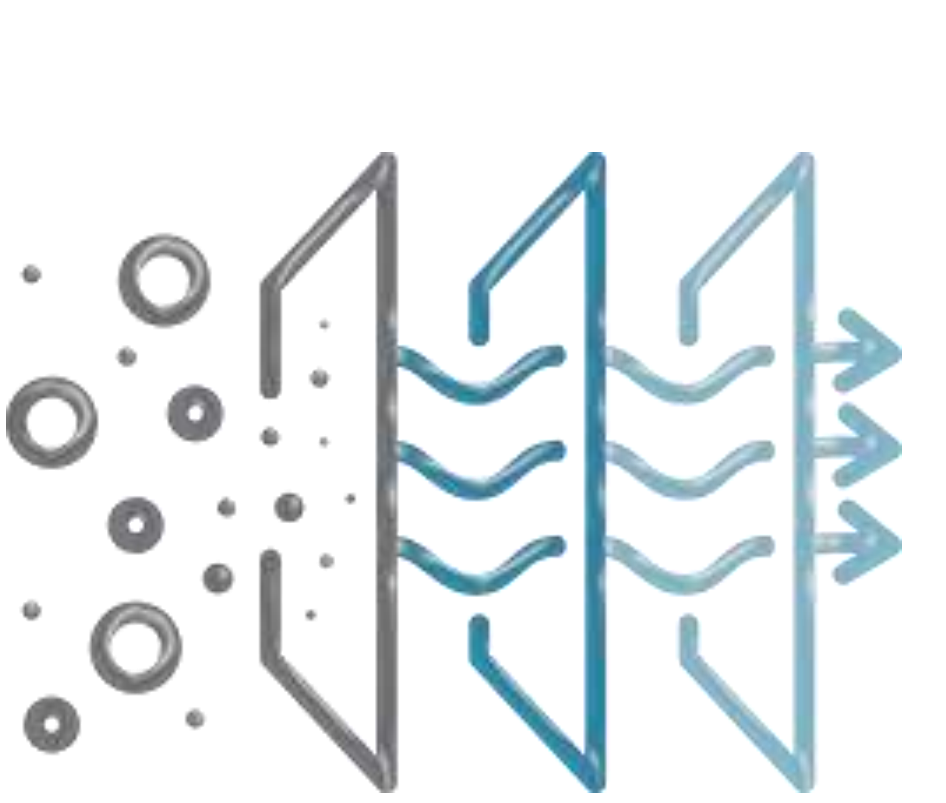
# Activities

# Fun

**Some publications we achieved in 2022. (all papers are listed on <https://jmo-lab.net/publications>)**

- Gao YL, Tian EZ\*, Mo JH\*, Electrostatic polydopamine-interface-mediated (e-PIM) filters with tuned surface topography and electrical properties for efficient particle capture and ozone removal, *Journal of Hazardous Materials*, 2023, 441, 129821.
- Chen QW, Tian EZ, Luo ZY, Mo JH\*, Adsorption film with sub-milli-interface morphologies via direct ink writing for indoor formaldehyde removal, *Journal of Hazardous Materials*, 2022, 427, 128190.
- Chen Z, Wu QY, Xu Y, Mo JH\*, Partitioning of airborne PAEs on indoor impermeable surfaces: a microscopic view of the sorption process, *Journal of Hazardous Materials*, 2022, 424, 127326.
- Chen Z, Chen QW, Xu Y, Mo JH\*, Partitioning characteristics of indoor VOCs on impermeable surfaces covered by film-phase DnBP and DEHP, *Journal of Hazardous Materials Advances*, 2022, 8, 100191.
- Mo JH, Gu YT, Tian EZ\*, Efficiently remove submicron particles by a novel foldable electrostatically assisted air coarse filter, *Separation and Purification Technology*, 2022, 288, 120631.
- Gao YL, Tian EZ, Zhang YP, Mo JH\*, Utilizing electrostatic effect in fibrous air filters for efficient airborne particles removal: Principles, fabrication, and material properties, *Applied Materials Today*, 2022, 26, 101369.
- Wang Y, Yu T, Mo JH\*, The influence of indoor environmental factors on toluene uptake rate of a tube-type diffusive sampler, *Journal of Building Engineering*, 2022, 104587.
- Tian EZ, Gao YL, Mo JH\*, Experimental studies on electrostatic-force strengthened particulate matter filtration for built environments: Progress and perspectives, *Building and Environment*, 2023, 228, 109782.
- Gong QP, Kou FC, Sun XY, Zou Y, Mo JH, Wang X\*, Towards zero energy buildings: A novel passive solar house integrated with flat gravity-assisted heat pipes. *Applied Energy*, 2022, 306: 117981
- Niu ZL, Xiao C, Mo JH, Zhang L, Chen C\*, Investigating the influence of metal-organic framework loading on the filtration performance of electrospun nanofiber air filters, *ACS Applied Materials & Interfaces*, 2022, 14(23), 27096-27106.
- Kou FC, Gong QP, Zou Y, Mo JH, Wang X\*. Solar application potential and thermal property optimization of a novel zero-carbon heating building. *Energy and Buildings*, 2022, 112688.
- Fang L, Liu NR, Liu W, Mo JH, Zhao ZH, Kan HD, Deng FR, Huang C, Zhao B, Zeng XG, Sun YX, Qian H, Sun CJ, Guo JG, Zheng XH, Zhang YP\*, Indoor formaldehyde levels in residences, schools, and offices in China in the past 30 years: a systematic review, *Indoor Air*, 2022, 32(10), e13141.
- Wang Y, Yu T, Mo JH\*, Prediction and validation of diffusive uptake rates for indoor volatile organic compounds in axial passive samplers, *Energy and Built Environment*, 2022, accepted. Publication date: 2022-7-16.
- ....





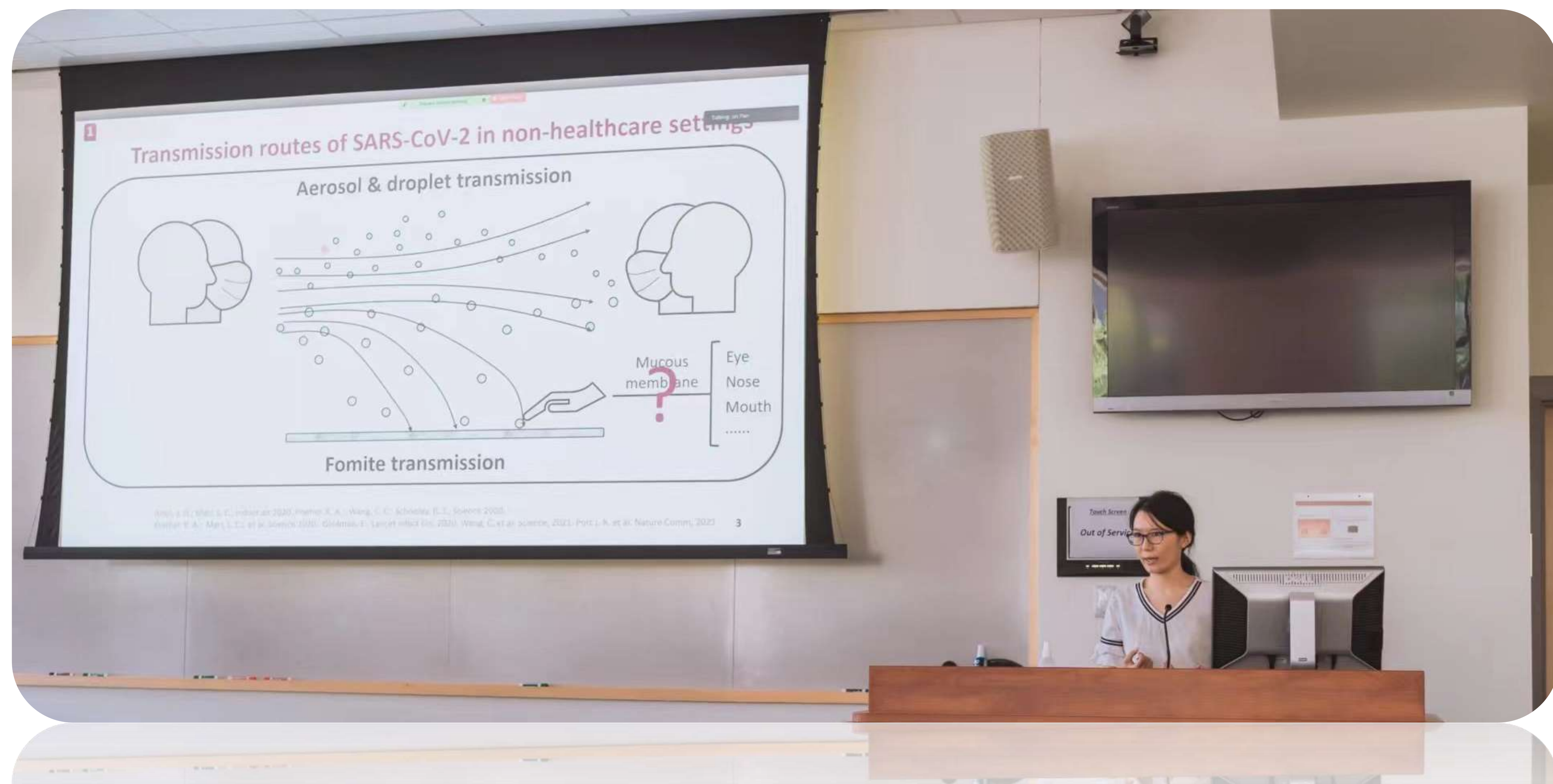
# Research

# Activities

# Fun



Yuting finished his Master dissertation defense.  
Congratulations to Yuting!



Graduation ceremony for Yuting  
From left to right, 1<sup>st</sup> row: Yilun GAO, Qiwei CHEN, Yuting GU, Jinhan MO, Yan WANG  
2<sup>nd</sup> row: Fanxuan XIA, Wuwei ZOU, Xiao LEI



Yuting GU and Dr. Jinhan MO

Jin PAN finished her PhD dissertation defense @ Virginia Tech.  
Congratulations to Dr. PAN!

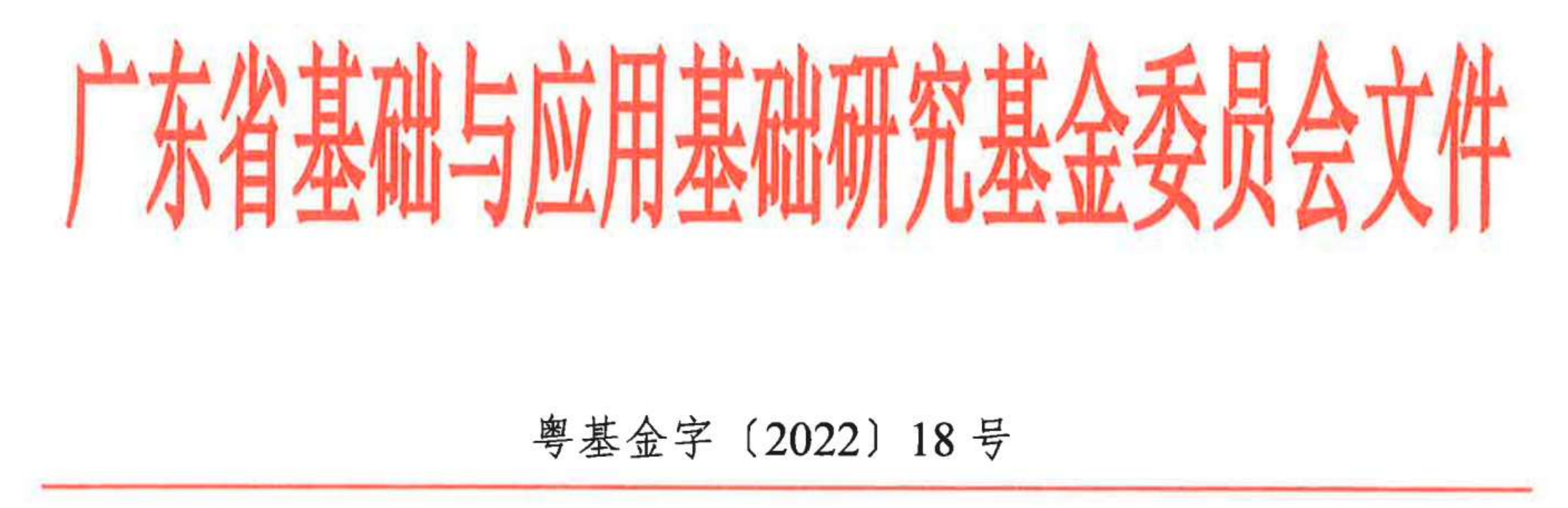




Prof. Yunfa CHEN, Prof. Maoshen YAO and Dr. Jinhan taking a photo before the oral defense for the 14<sup>th</sup> five-year National Key Research and Development Program of China



- Enze Tian was approved to lead the Guangdong Basic and Applied Basic Research Foundation Project (2022A1515110897)



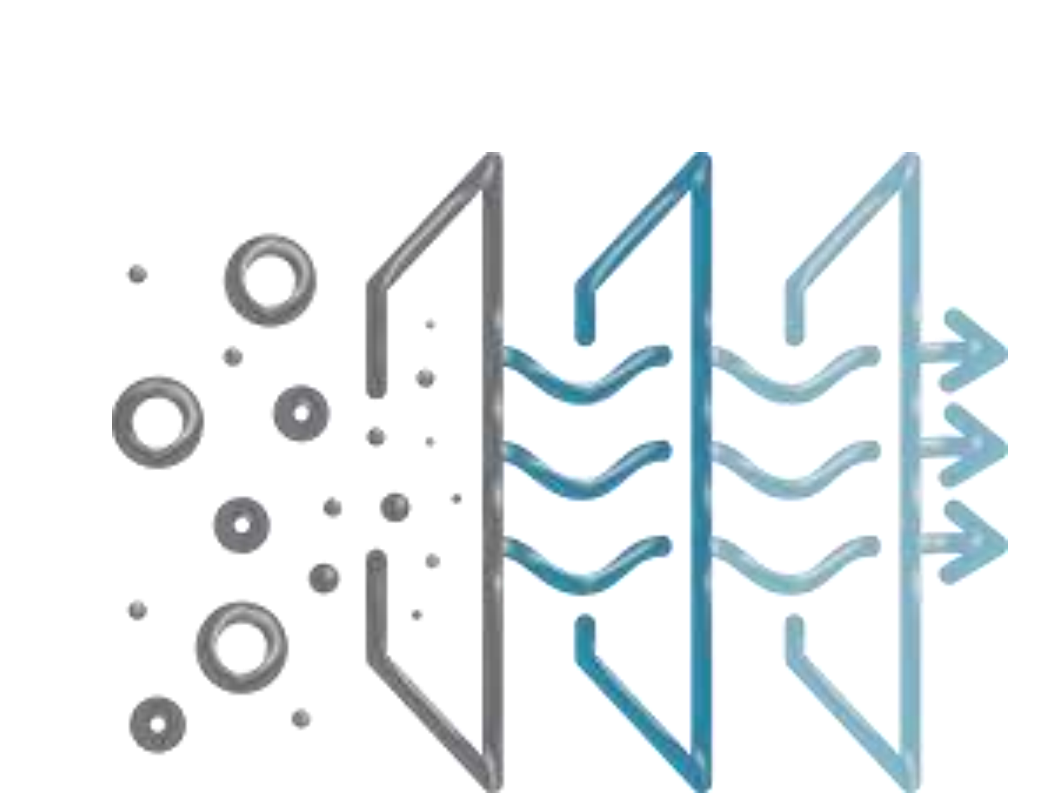
粤基金字〔2022〕18号

广东省基础与应用基础研究基金委员会关于下达  
2022年度省基础与应用基础研究基金联合  
基金（粤穗、粤深、粤佛、粤莞、粤惠）  
项目计划和项目资金的通知

2022A1515110607	基于非晶氧化镱材料的自供电日盲紫外探测 器研究	松山湖材料实 验室	隋新心	10	10	青年 基金
2022A1515110897	低风阻静电强化协同过滤颗粒物及去除臭氧 研究	松山湖材料实 验室	田恩泽	10	10	青年 基金
2022A1515110623	基于面内各向异性BP/PdSe2 转角异质结偏 振光电探测器的研究	松山湖材料实 验室	夏雪	10	10	青年 基金

- Enze Tian was approved to lead the China Postdoctoral Science Foundation Project (2022M723351)



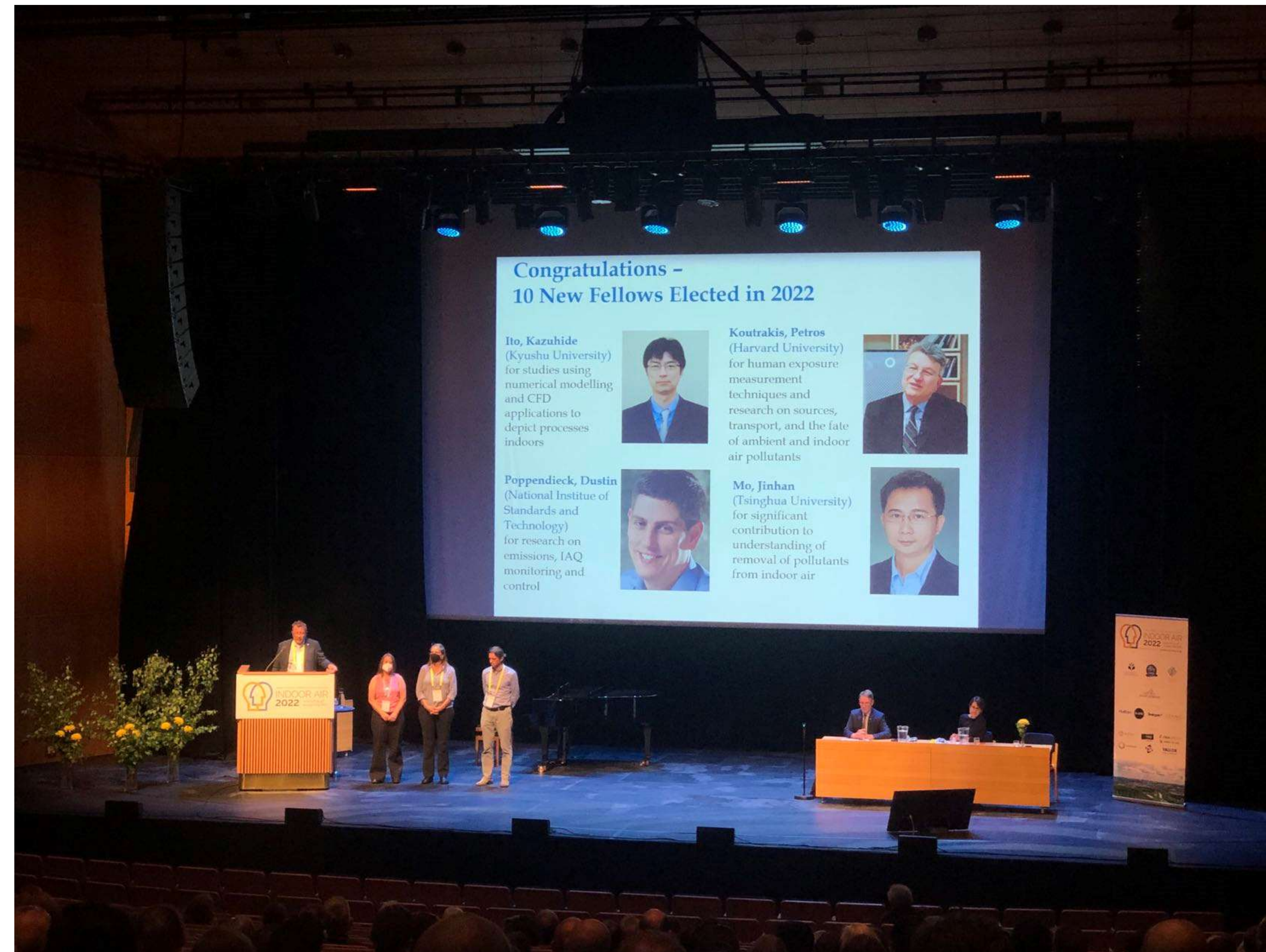


Research

Activities

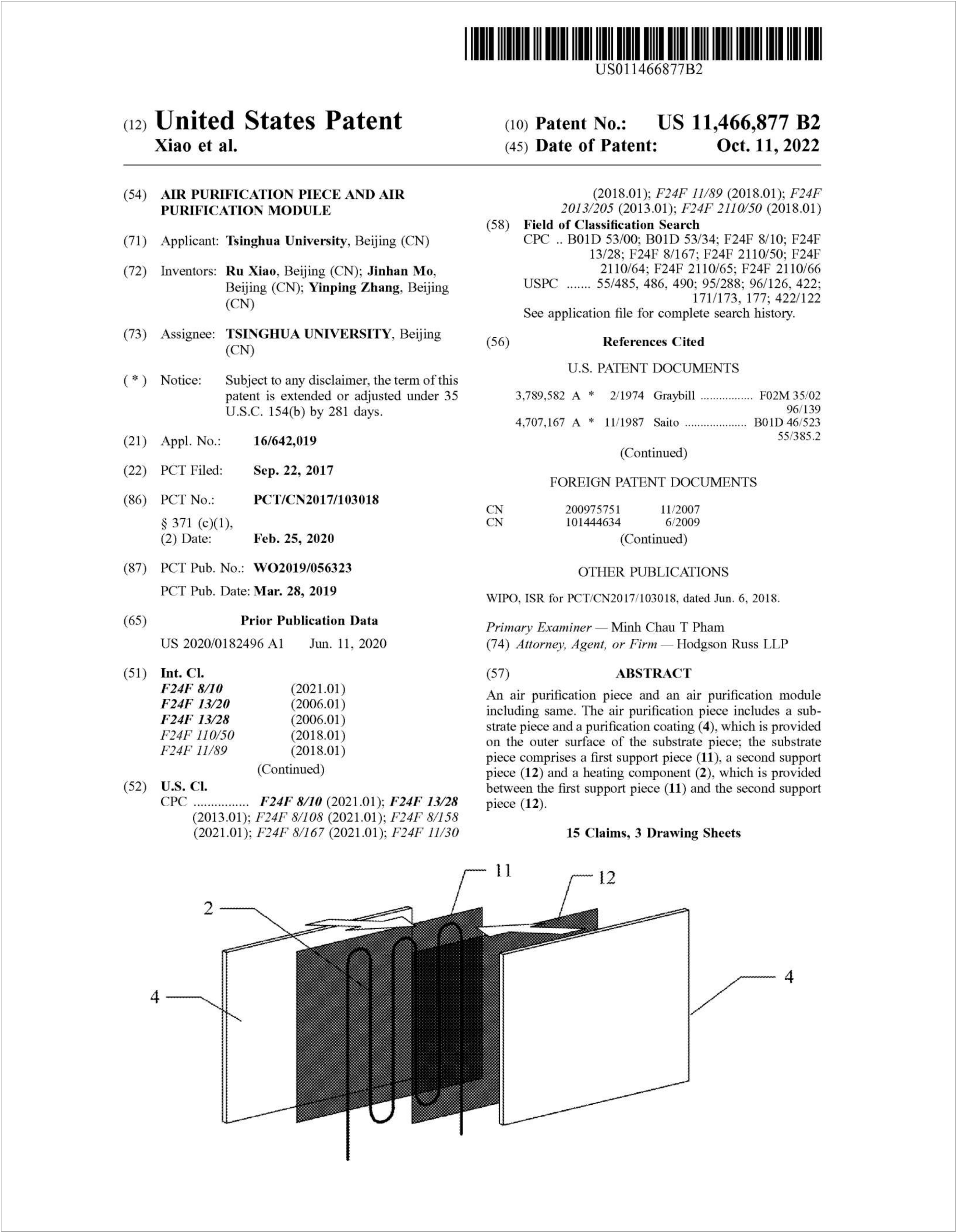
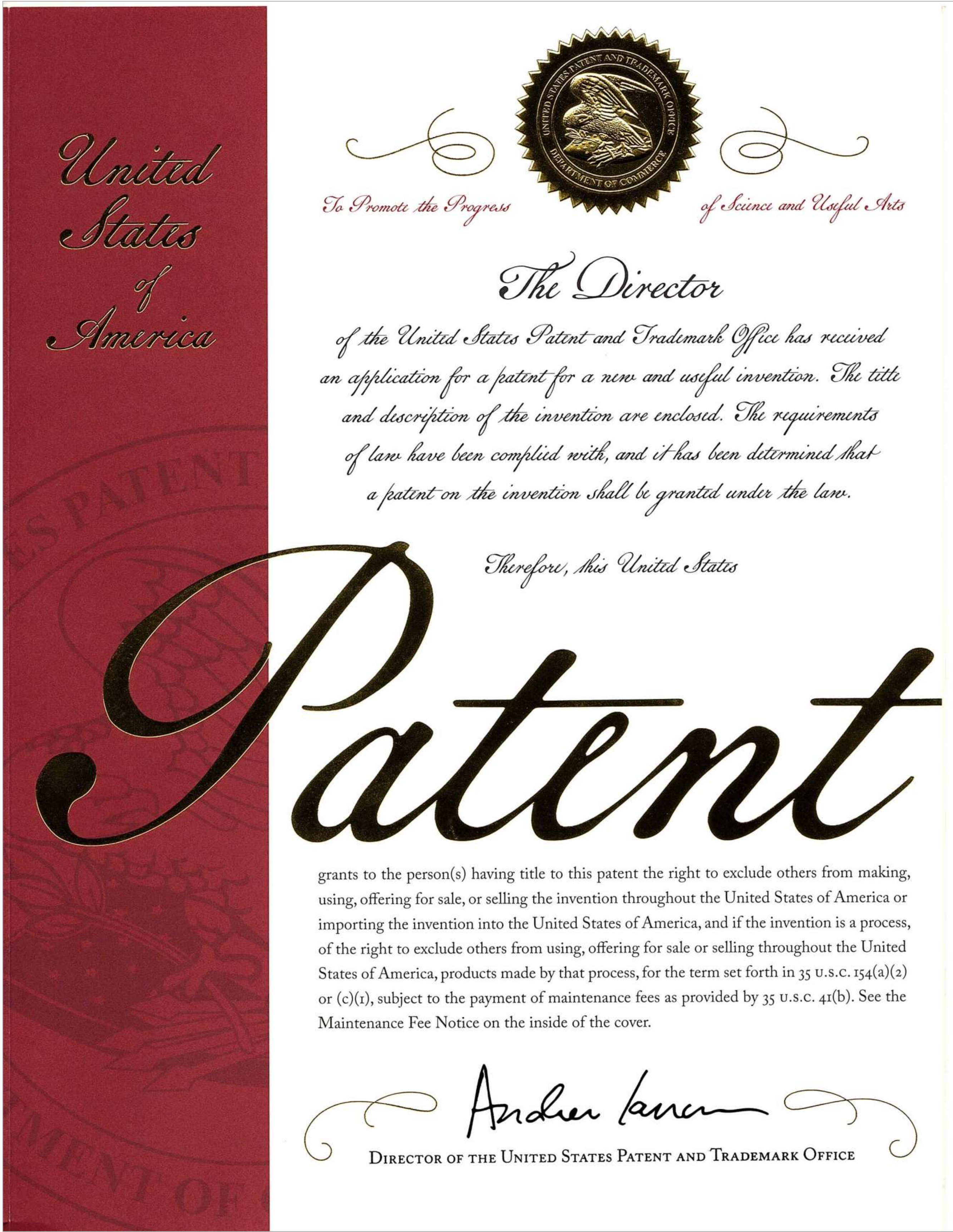
Fun

Dr. Jinhan MO was elected as the Academy Fellow of the International Society of Indoor Air Quality and Climate (ISIAQ).

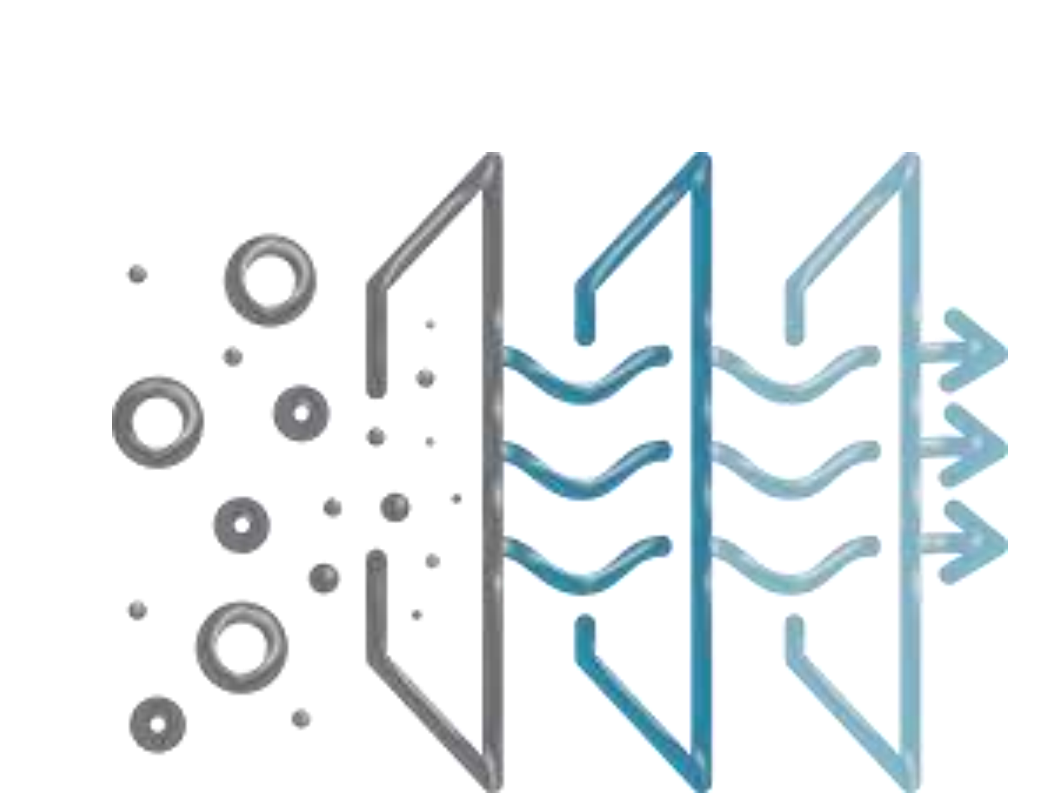




The patent “Air purification piece and air purification module” (US 11,466,877 B2) has being authorized.







# Research

# Activities

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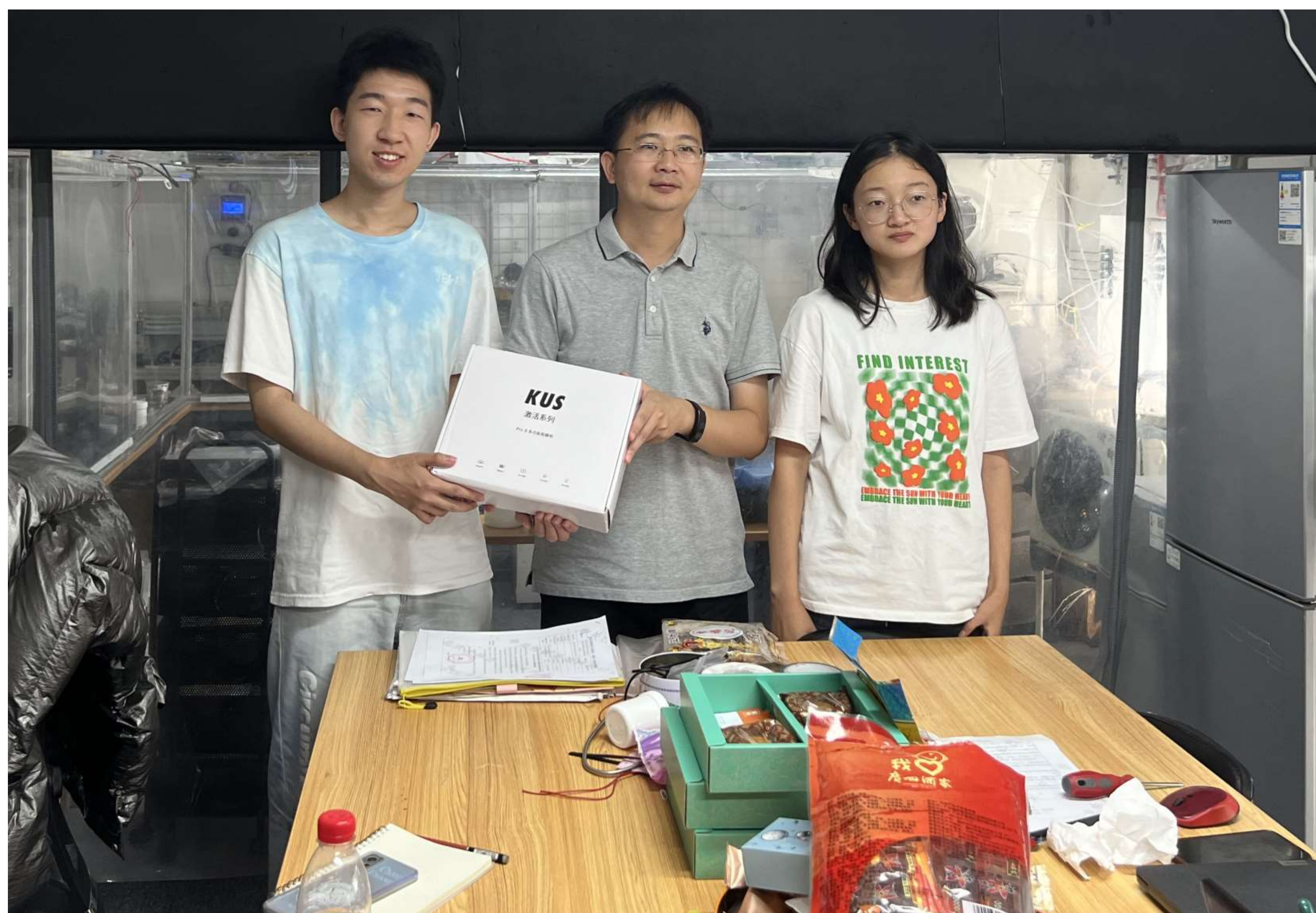
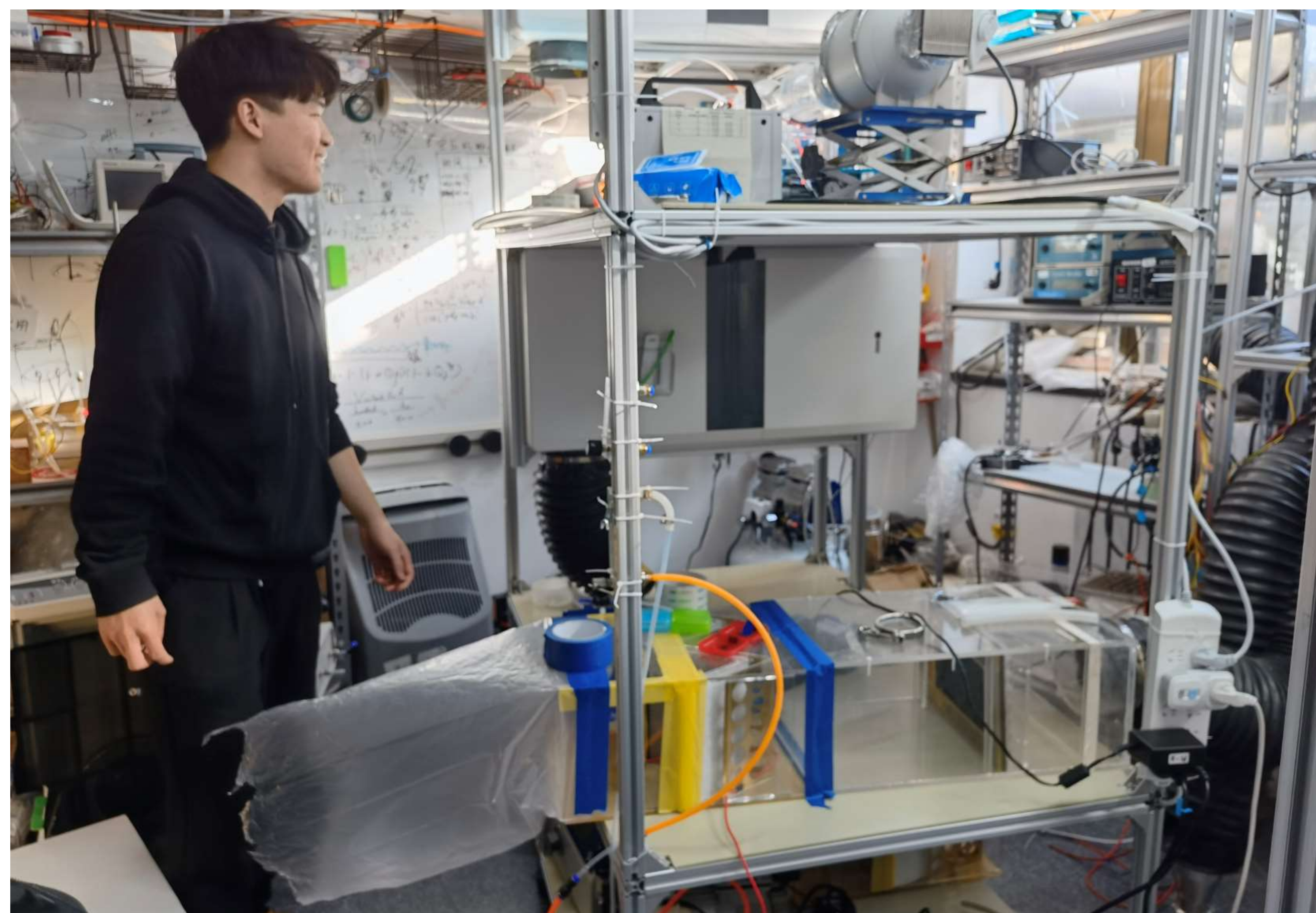
Dr. Jinhan MO, Qiwei CHEN, Enze TIAN, Prof. Yinpinng ZHANG, Yilun GAO, Xiao LEI, Ru XIAO and Jin PAN got the Silver Award of the 16<sup>th</sup> Beijing Invention and Innovation Competition, 2022, “***In-situ regenerable indoor particulate matter and VOCs pollution purification technology with low resistance and high efficiency***”







# Research Activities Fun





Happy New Year 2023!

土木工務館

建筑学院  
建筑技术科学系  
School of Architecture  
Department of Building Science

清华大学  
绿色建筑产业研究中心  
11.1.1 土木工務館

建筑环境与设备  
研究所  
Institute of Built Environment

清华大学  
建筑环境与设备研究所  
北京市重点实验室