生物质与功能材料研究所

Institute of Biomass & Functional Materials

Humic Substance Tanning Agent Derived Functional Leather: Enabling Personal Thermal Management and Solar-Driven Seawater Desalination

Reporter: Ruilong Li   Email:liruilong0313@163.com

Advisor: Prof. Dr. Longfang Ren

Prof. Dr. Taotao Qiang

生物质与功能材料研究所

Institute of Biomass & Functional Materials

CONTENTS

1 Research background

1 | Research background

- In the leather production process, chrome tanning agents, fatliquoring agent and dyes are the main sources of pollution.

ECHA
EUROPEAN CHEMICALS AGENCY

All news

Chromium trioxide widely used in plating and surface treatment

中华人民共和国中央人民政府

中华人民共和国工业和信息化部令

第 15 号

铬化合物生产建设许可管理办法

（二）发展目标

到 2025 年，皮革行业的发展目标是：

——生产效益平稳增长。保持皮革行业主要产品产销量的平稳增长，稳定出口，扩大内需，提高产品附加值，逐步提高全员劳动生产率，充分发挥增长潜力，提高产业链供应链现代化水平，促进皮革业高质量发展取得重大进展。

——科技创新水平不断提升。推动建立产学研用相结合、全产业链共同参与的创新体系，在新材料、新技术、新装备等关键技术和关键领域实现突破，规模以上企业科技研发（R&D）投入年均增长 10%，专利数量年均增长 10%。

专栏 1 研发设计提升工程

1. 新技术和新工艺

推动制革和毛皮硝染行业无铬鞣、无盐少盐制革及废水脱盐、除臭、生物制革等技术的研发和应用；探索和研发毛皮硝染行业重金属媒染工艺的替代工艺。

2. 新材料

研发功能突出的无铬鞣剂、整饰材料及助剂，皮革疏水性调控材料，灰碱替代材料，胶原生物材料，以铬鞣革屑为基材的复合新材料；研发兼顾减震、回弹、轻量、环保等功能的高性能鞋底材料，加大中草药等中国元素材料在中底、鞋垫等部件上的抗菌应用研发，加大阻燃、隔热、保温等各种功能性材料的研发。

3. 新产品

研发性能突出的防水、防污、易清洁、抗菌防霉、导电/防辐射、阻燃皮革等新产品。开发时尚引领型皮革材料及适合未来发展趋势的汽车用皮革、家居用皮革等，进一步拓宽皮革应用领域。

4. 新设备

开发高效通过式去肉机、真空干燥机铺皮收皮机器人、自动绷板干燥机等制革新设备。

5. 设计新平台和新模式

研发或改造产品设计软硬件，建设品牌的设计数据库，采用 3D 与 CAD 设计、沉浸式技术、虚拟仿真设计和视觉化呈现，构建与未来数字化制品业相匹配的设计技术平台和样品研发模式。

- China, the European Union and other countries are increasingly strict on the use of chromium.

- **China'S 14th Five-Year DEVELOPMENT** also pointed out that **by 2025**, we should achieve technological breakthroughs in tanning agent materials and develop functional leather with excellent performance.

1 | Research background

thebmj covid-19 Research Education News & Views Campaigns Jobs Archive For authors Hosted Search

Comment

Of 1265 annual excess winter deaths per million over the past 10 years, 2.4% were due to influenza either directly or indirectly. The decline in influenza related deaths is probably due to immunisation and to a reduction in the number of new viral strains. With influenza causing such a small proportion of excess winter deaths, measures to reduce cold stress offer the greatest opportunities to reduce current levels of winter mortality. Warm housing is important but it can coexist with high winter mortality,[5] and outdoor cold stress has been independently associated with high excess winter mortality.[4] Campaigns to reduce exposure to cold outdoors provide obvious scope for future preventive action.

Acknowledgments

The Office for National Statistics supplied mortality and population data and the Royal Meteorological Office supplied the temperature data.

Contributors: Both authors designed the study, assessed the data, and wrote the paper. GD computed the data and WRK drafted the paper. Both are guarantors for the paper.

Footnotes

Funding EU Biomed grant.

Competing interests None declared.

- **1265 deaths per 1 million people are attributable to cold stress**

BMJ 2002; 324 doi: https://doi.org/10.1136/bmj.324.7329.89

- **The mortality rate caused by low temperatures is much higher than that caused by high temperatures. The net mortality burden caused by low temperatures increases by 49.9%.**

Masselot, P., Mistry, M.N., Rao, S. *et al.* Estimating future heat-related and cold-related mortality under climate change, demographic and adaptation scenarios in 854 European cities. *Nat Med* **31**, 1294–1302 (2025). https://doi.org/10.1038/s41591-024-03452-2

nature medicine

Explore content About the journal Publish with us

nature > nature medicine > articles > article

Article | Open access | Published: 27 January 2025

Estimating future heat-related and cold-related mortality under climate change, demographic and adaptation scenarios in 854 European cities

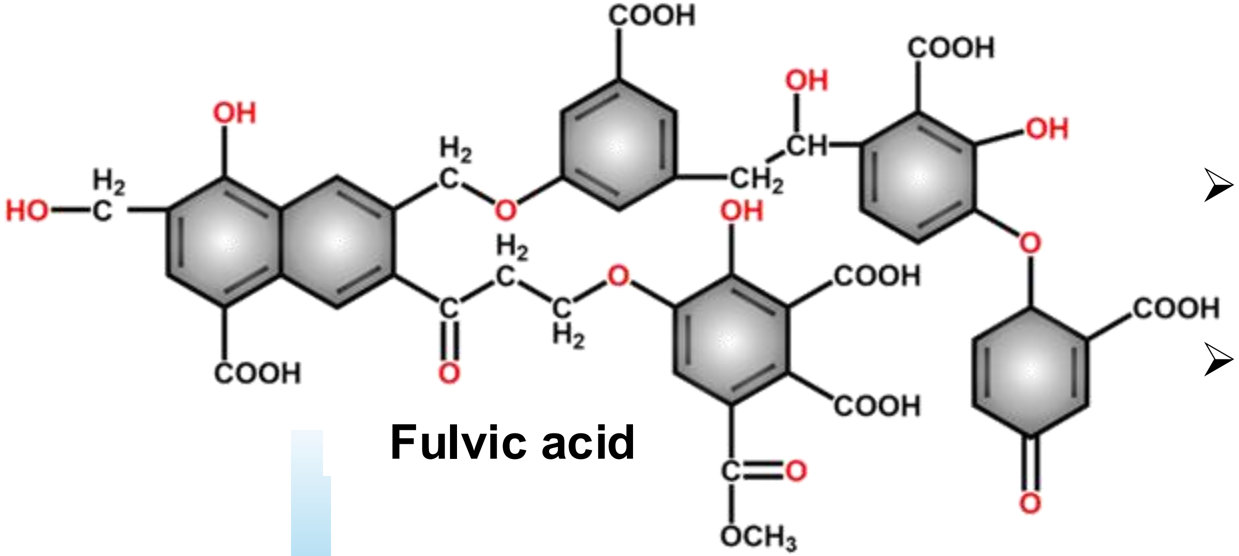
Pierre Masselot, Malcolm N. Mistry, Shilpa Rao, Veronika Huber, Ana Monteiro, Evangelia Samoli, Massimo Stafoggia, Francesca de'Donato, David Garcia-Leon, Juan-Carlos Ciscar, Luc Feyen, Alexandra Schneider, Klea Katsouyanni, Ana Maria Vicedo-Cabrera, Kristin Aunan & Antonio Gasparrini

Nature Medicine **31**, 1294–1302 (2025) | Cite this article

Abstract

Previous health impact assessments of temperature-related mortality in Europe indicated that the mortality burden attributable to cold is much larger than for heat. Questions remain as to whether climate change can result in a net decrease in temperature-related mortality. In this study, we estimated how climate change could affect future heat-related and cold-related mortality in 854 European urban areas, under several climate, demographic and adaptation scenarios. We showed that, with no adaptation to heat, the increase in heat-related deaths consistently exceeds any decrease in cold-related deaths across all considered scenarios in Europe. Under the lowest mitigation and adaptation scenario (SSP3-7.0), we estimate a net death burden due to climate change increasing by 49.9% and cumulating 2,345,410 (95% confidence interval = 327,603 to 4,775,853) climate change-related deaths between 2015 and 2099. This net effect would remain positive even under high adaptation scenarios, whereby a risk attenuation of 50% is still insufficient to reverse the trend under SSP3-7.0. Regional differences suggest a slight net decrease of death rates in Northern European countries but high vulnerability of the Mediterranean region and Eastern Europe areas. Unless strong mitigation and adaptation measures are implemented, most European cities should experience an increase of their temperature-related mortality burden.

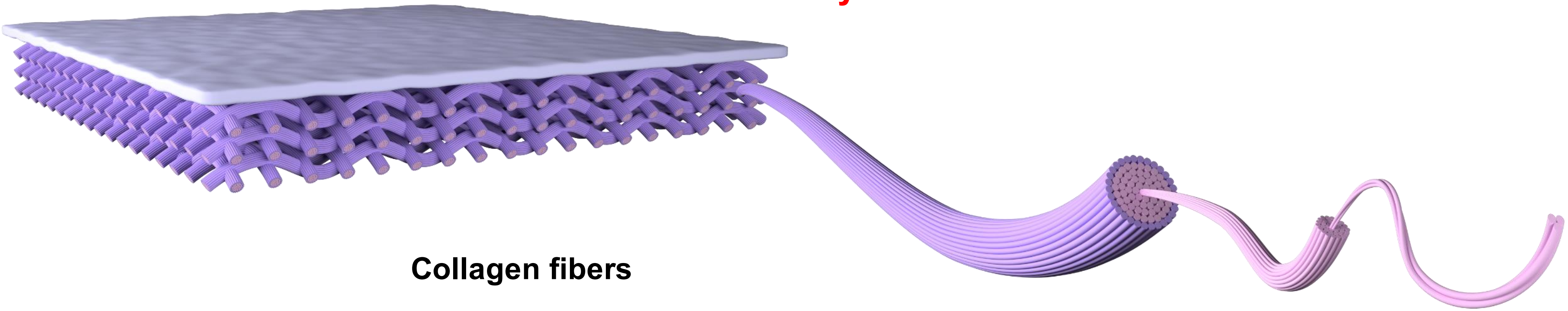
1 | Research background



Fulvic acid

- Rich in oxygen-containing functional groups
- Excellent photothermal conversion performance

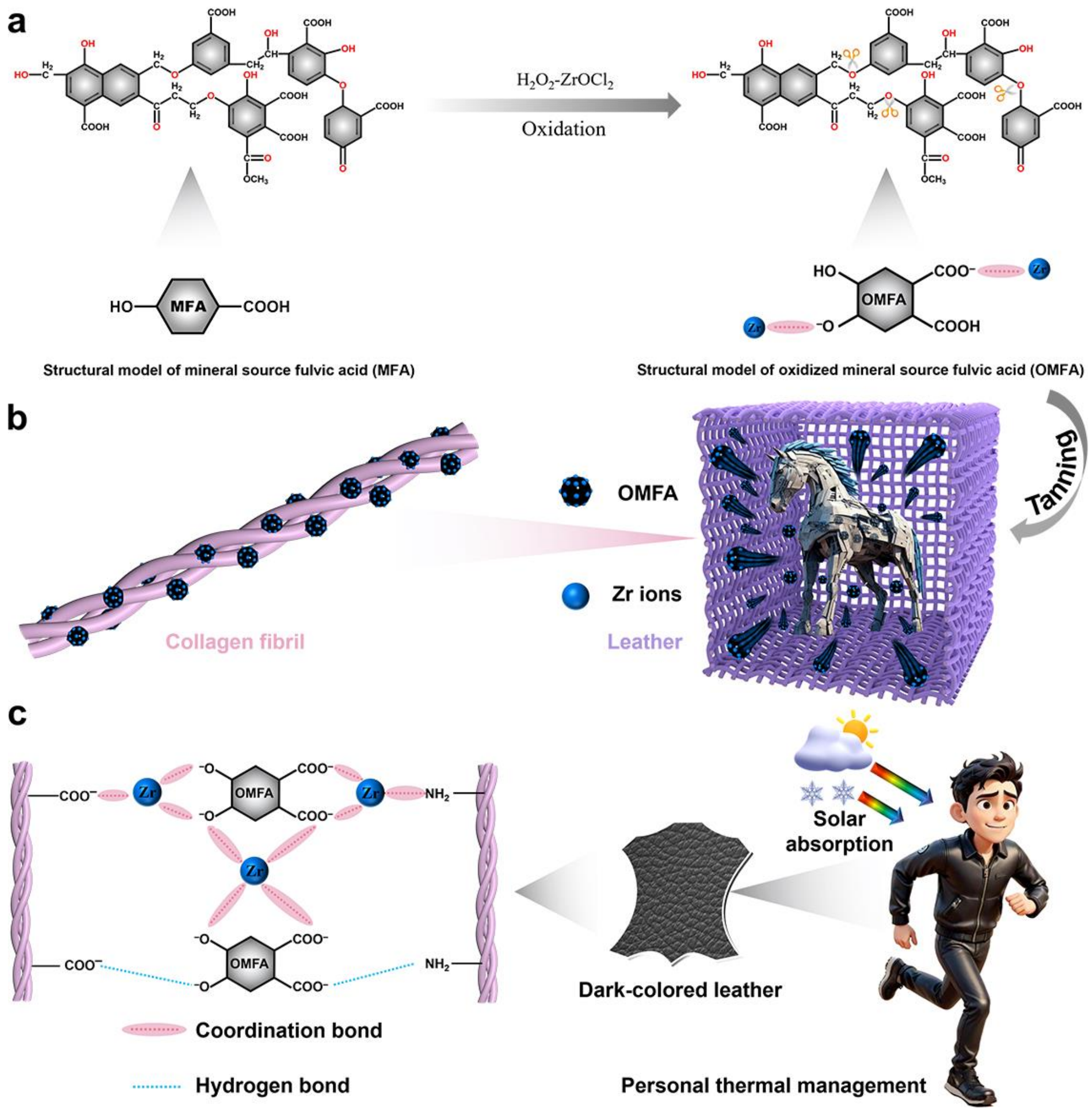
Based on mineral source fulvic acid, modified fulvic acid from humus to prepare functional chrome-free tanning agent. During the tanning process, cross-linking and personal heat management were achieved simultaneously.



Collagen fibers

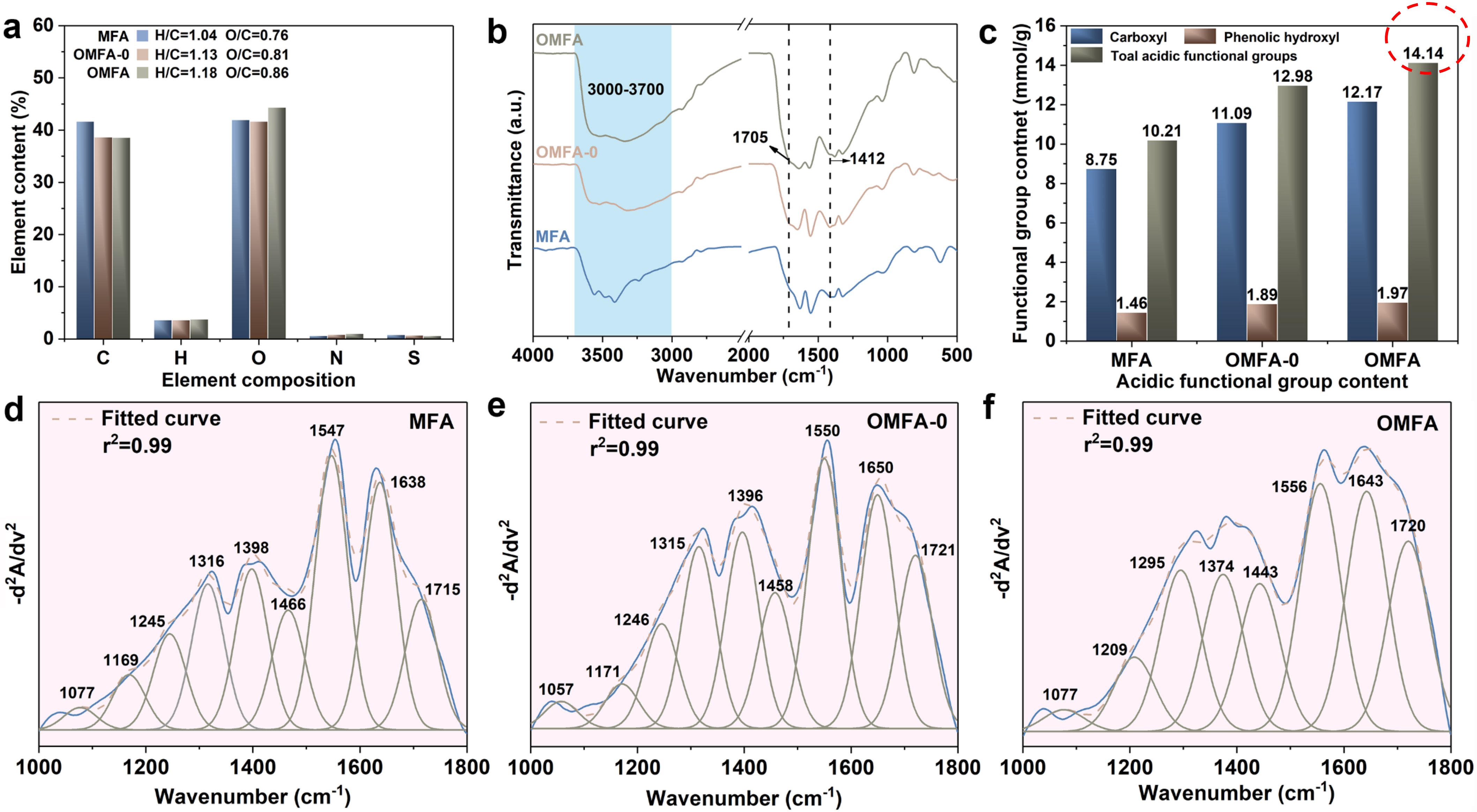
2 Results and discussion

Humic Substance Tanning Agent Derived Functional Leather: Enabling Personal Thermal Management and Solar-Driven Seawater Desalination



- $ZrOCl_2$ assisted H_2O_2 oxidation mineral fulvic acid (MFA) to preparation OMFA
- Reduce MFA molecular size
- Increase the content of oxygen-containing functional groups in MFA

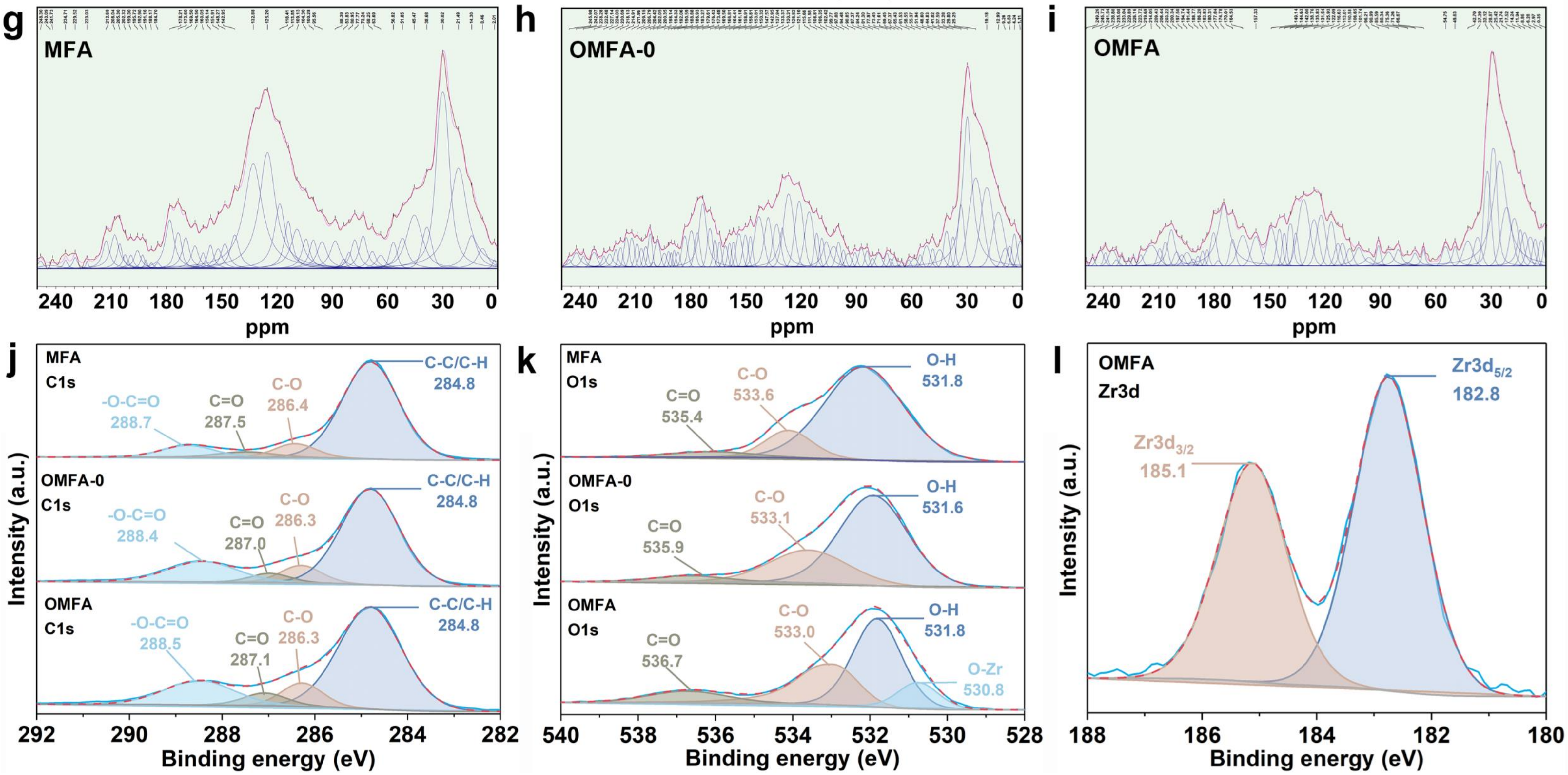
Molecular structure characterization



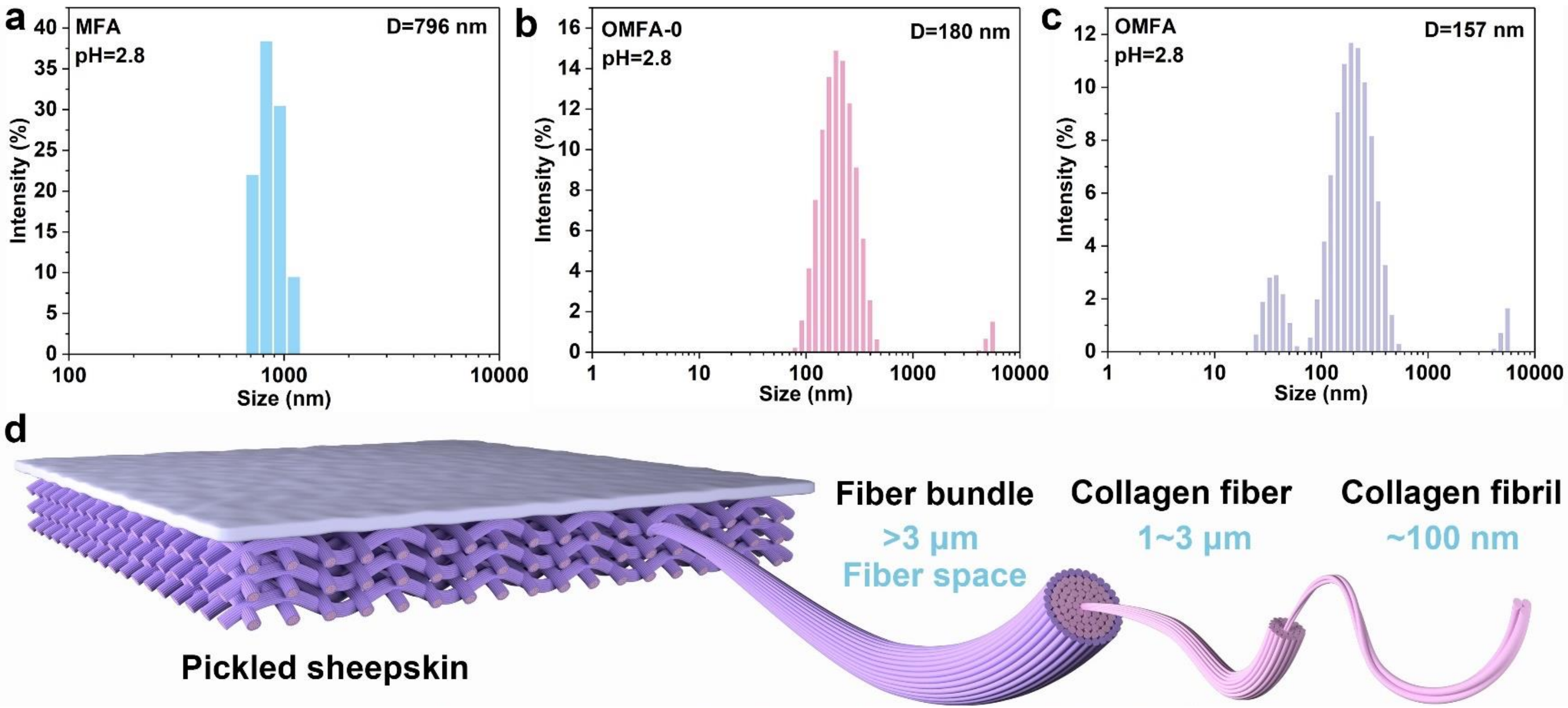
Molecular structure characterization

Sample	Chemical shift (ppm)	Relative peak (%)	Attribution
MFA	2.01-8.46	1.49	Aliphatic chain methyl carbon
	14.3	2.33	Aromatic methyl carbon
	21.49-45.47	29.84	Methylene and methine carbon
	51.85-73.24	5.88	Oxygenated methyl carbon
	77.77-95.56	5.78	Oxygenated olefin carbon
	100.28-118.41	12.64	Protonated aromatic carbon
	125.20-132.88	23.75	Aromatic bridging carbon
	142.95-148.27	3.04	Amino aromatic carbon
	151.91-156.14	1.85	Oxygen-bonded aromatic carbon
	160.05-184.70	7.16	Carboxyl carbon
	188.17-223.03	6.22	Carbonyl carbon
OMFA-0	1.11-9.26	3.42	Aliphatic chain methyl carbon
	12.99	4.07	Aromatic methyl carbon
	19.18-48.6	33.45	Methylene and methine carbon
	51.94-73.45	2.71	Oxygenated methyl carbon
	77.97-99.77	4.10	Oxygenated olefin carbon
	102.42-121.10	11.60	Protonated aromatic carbon
	126.82-133.27	9.61	Aromatic bridging carbon
	137.94-147.57	6.76	Amino aromatic carbon
	150.32-158.91	3.50	Oxygen-bonded aromatic carbon
	161.18-183.27	11.40	Carboxyl carbon
	186.93-224.03	9.36	Carbonyl carbon
OMFA	0.35-8.86	4.33	Aliphatic chain methyl carbon
	11.94-14.42	4.00	Aromatic methyl carbon
	17.52-49.63	37.65	Methylene and methine carbon
	54.75-75.36	2.44	Oxygenated methyl carbon
	80.34-96.21	3.58	Oxygenated olefin carbon
	101.74-122.09	9.55	Protonated aromatic carbon
	125.93-131.54	7.91	Aromatic bridging carbon
	135.83-144.63	5.32	Amino aromatic carbon
	149.14-157.33	4.02	Oxygen-bonded aromatic carbon
	164.53-183.83	12.32	Carboxyl carbon
	186.20-223.72	8.89	Carbonyl carbon

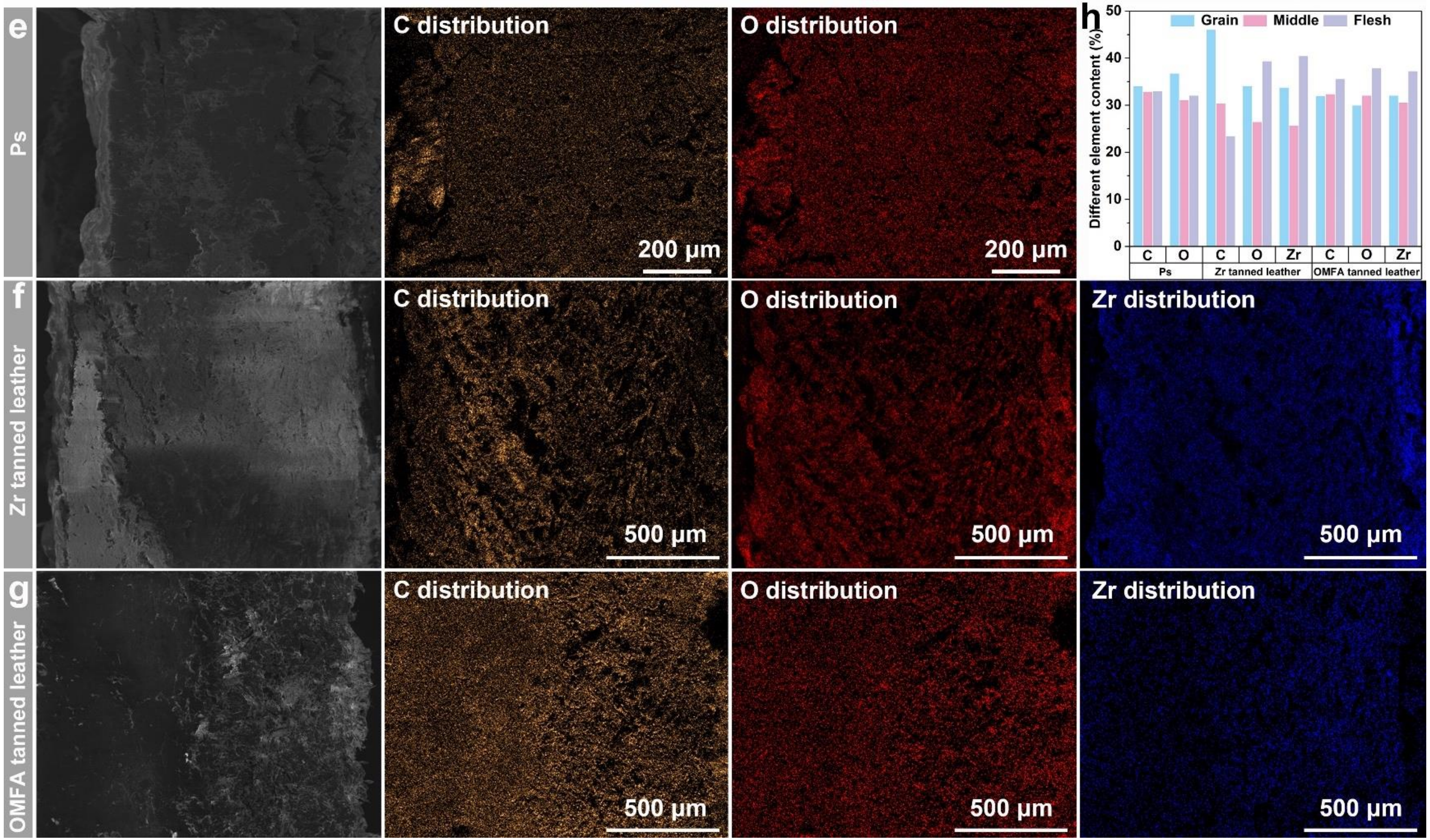
Molecular structure characterization



□ Molecular size of tanning agent

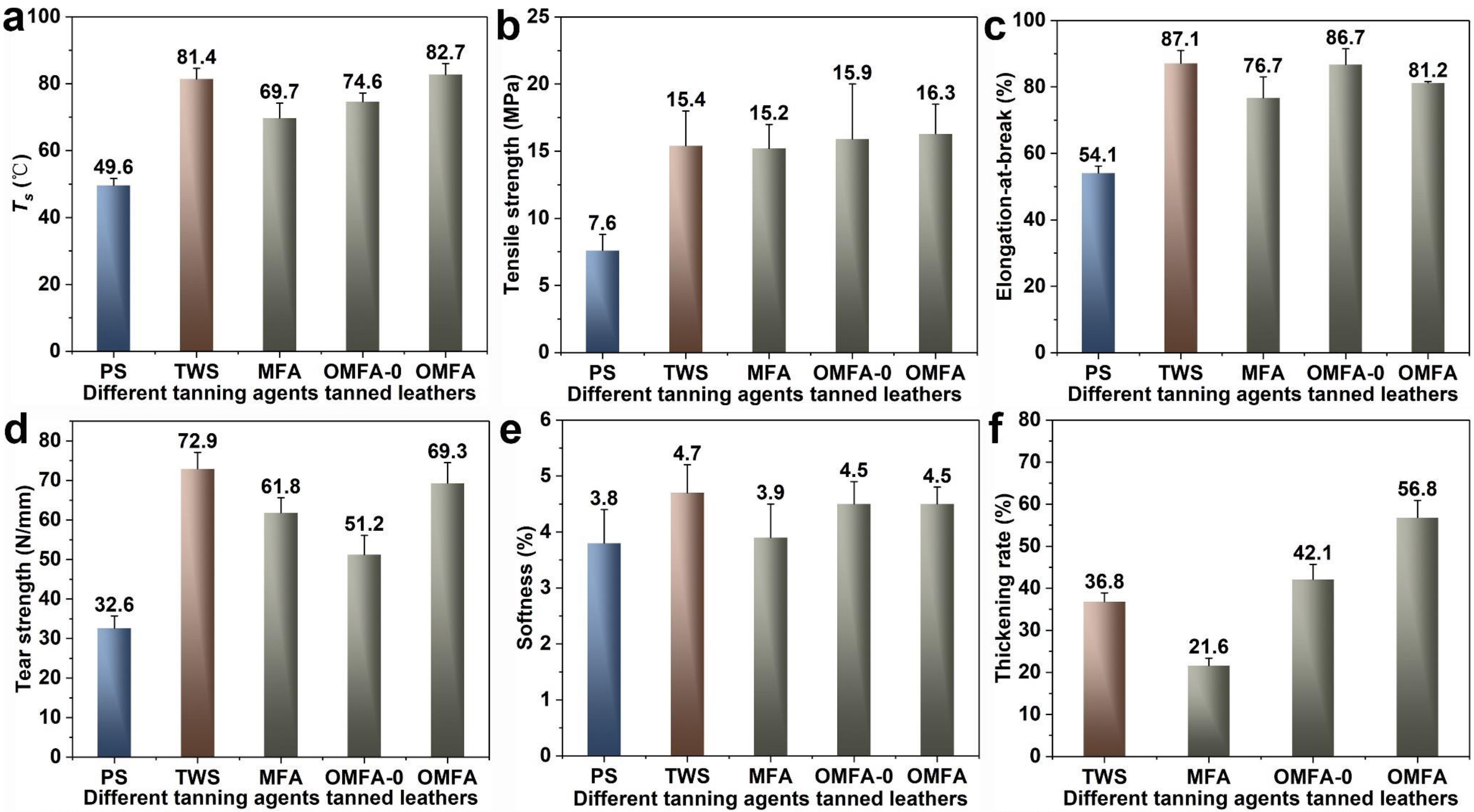


Trojan horse tanning effect

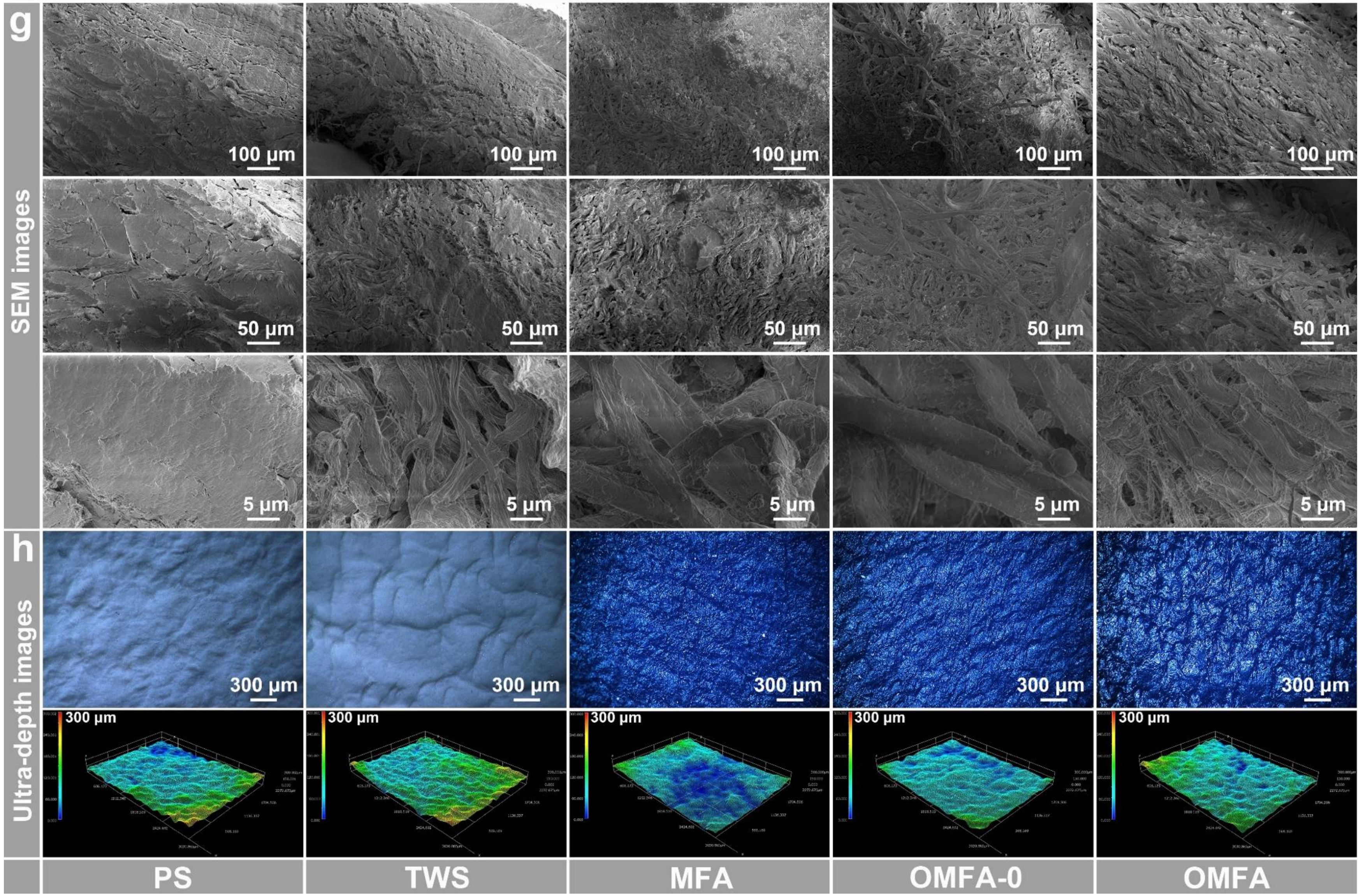


Trojan horse tanning effect

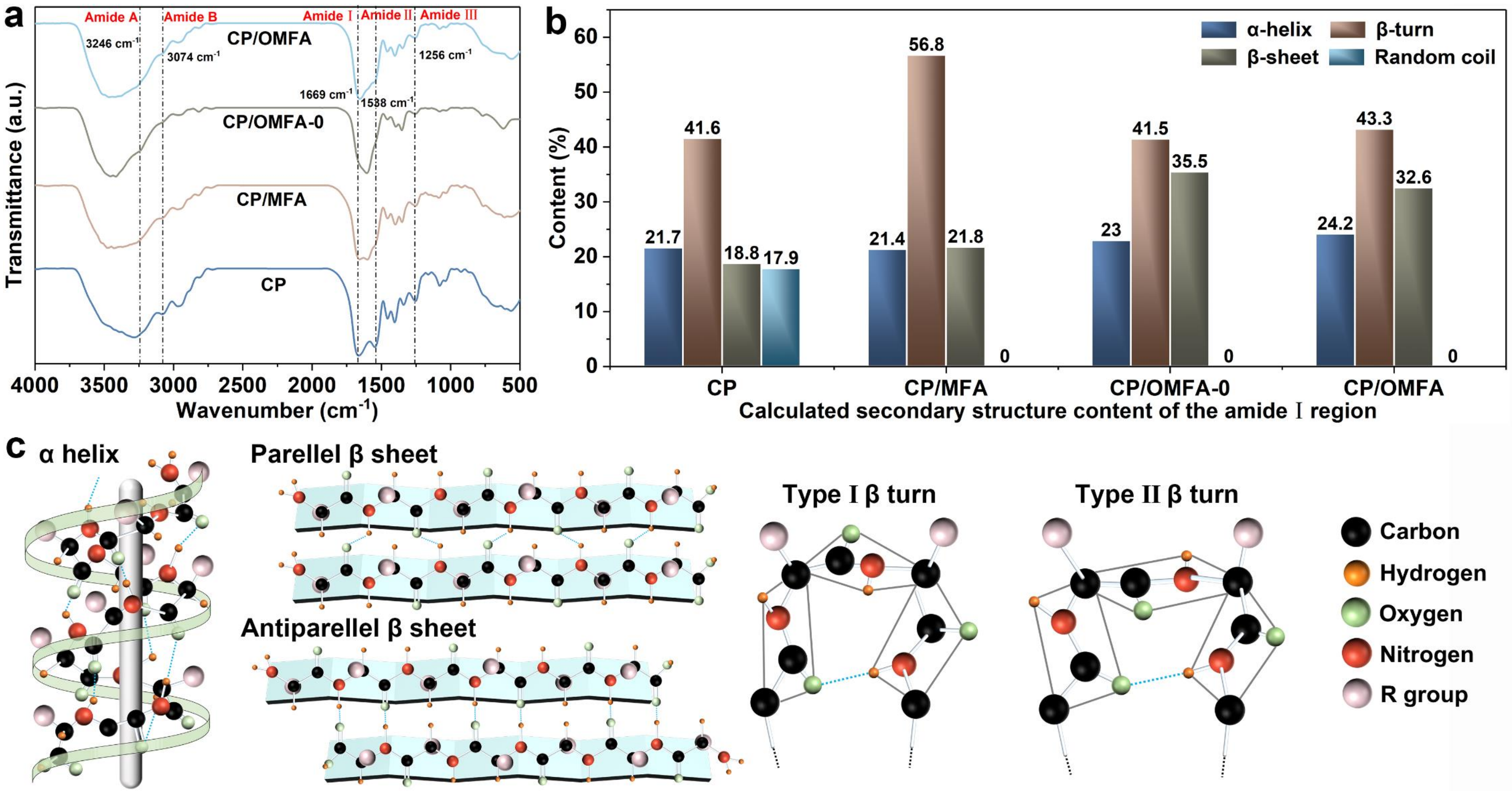
□ Physical and chemical properties of leather



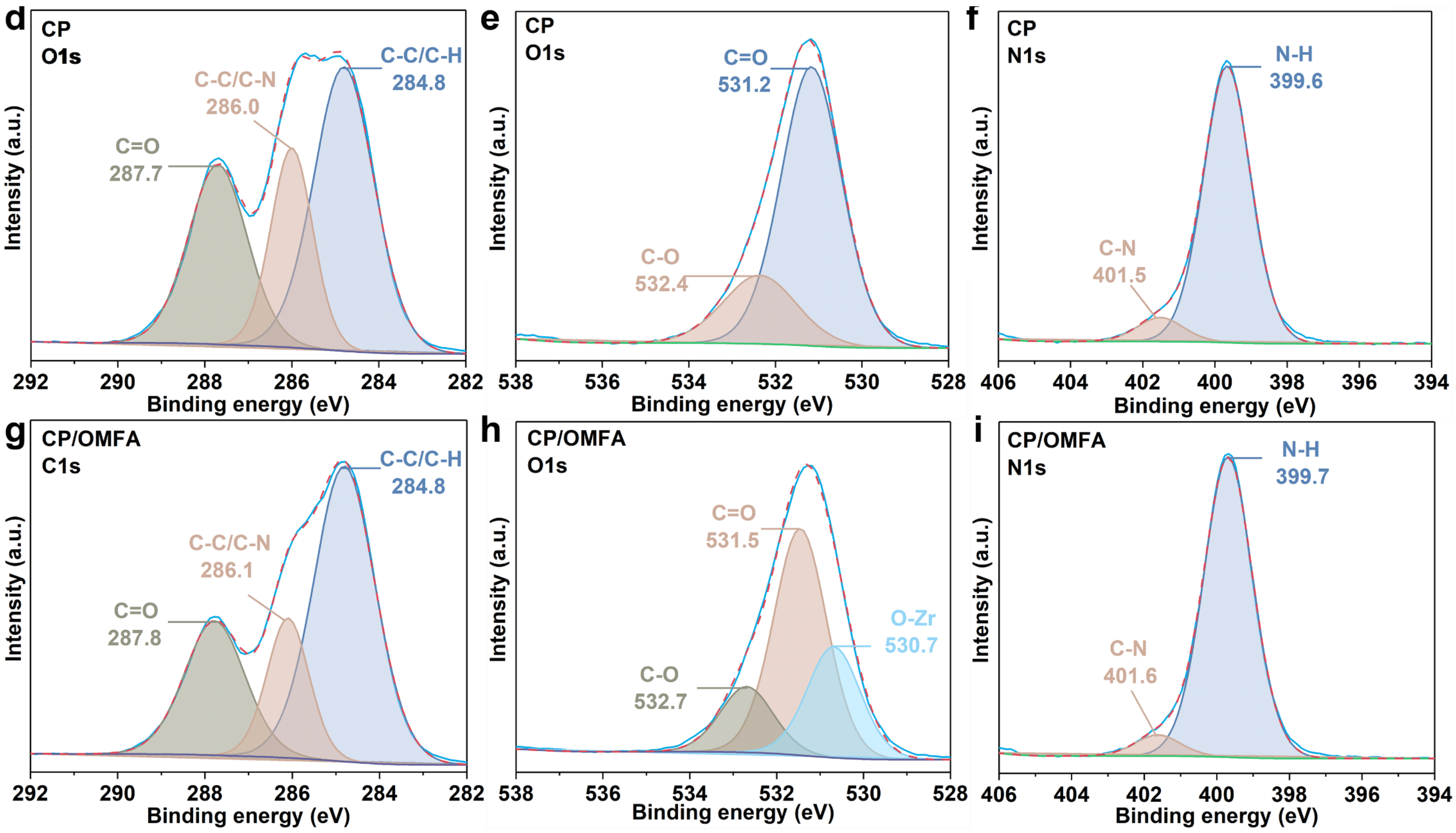
Microscopic morphology



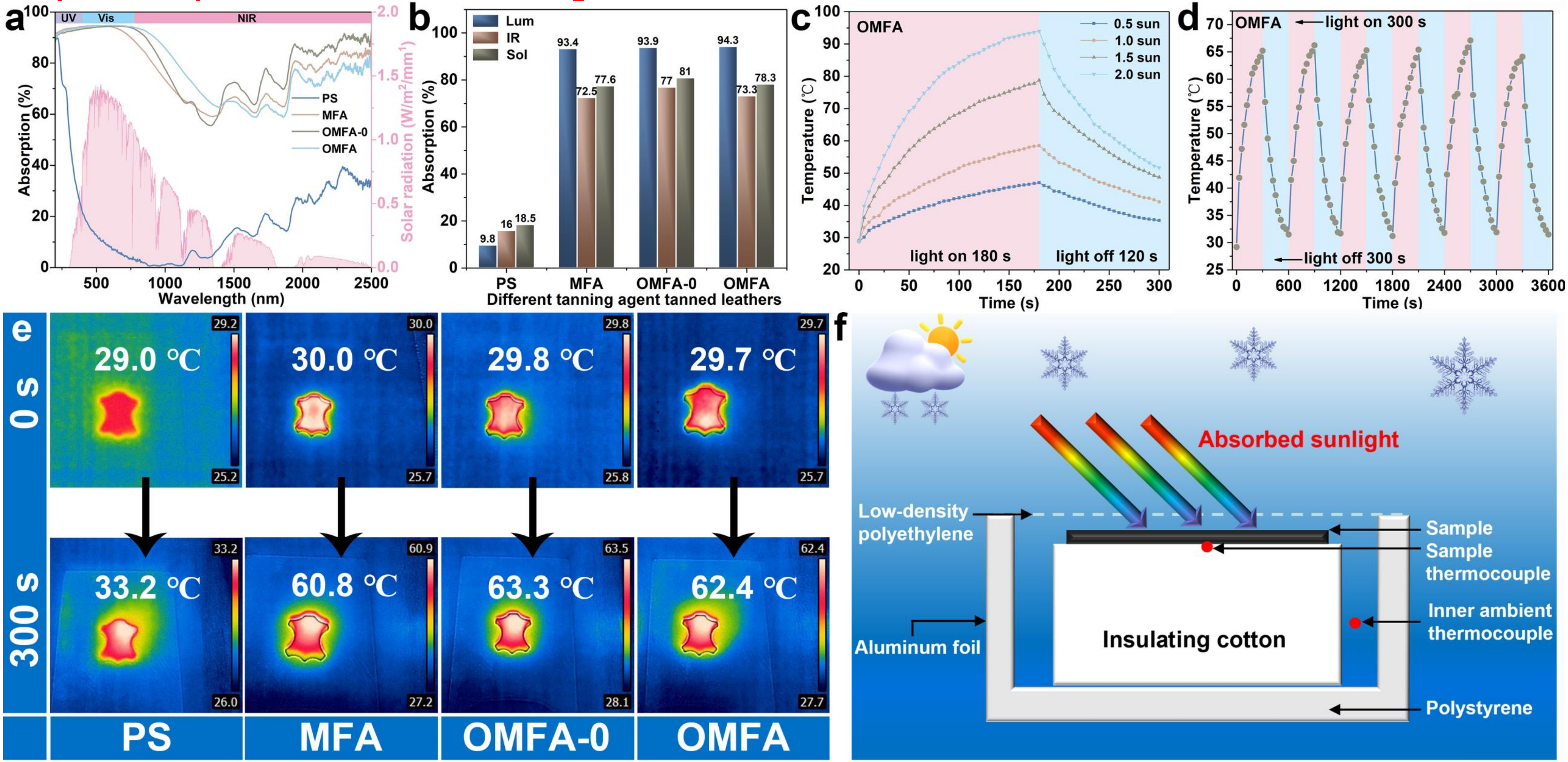
☐ Mechanism of cross-linking



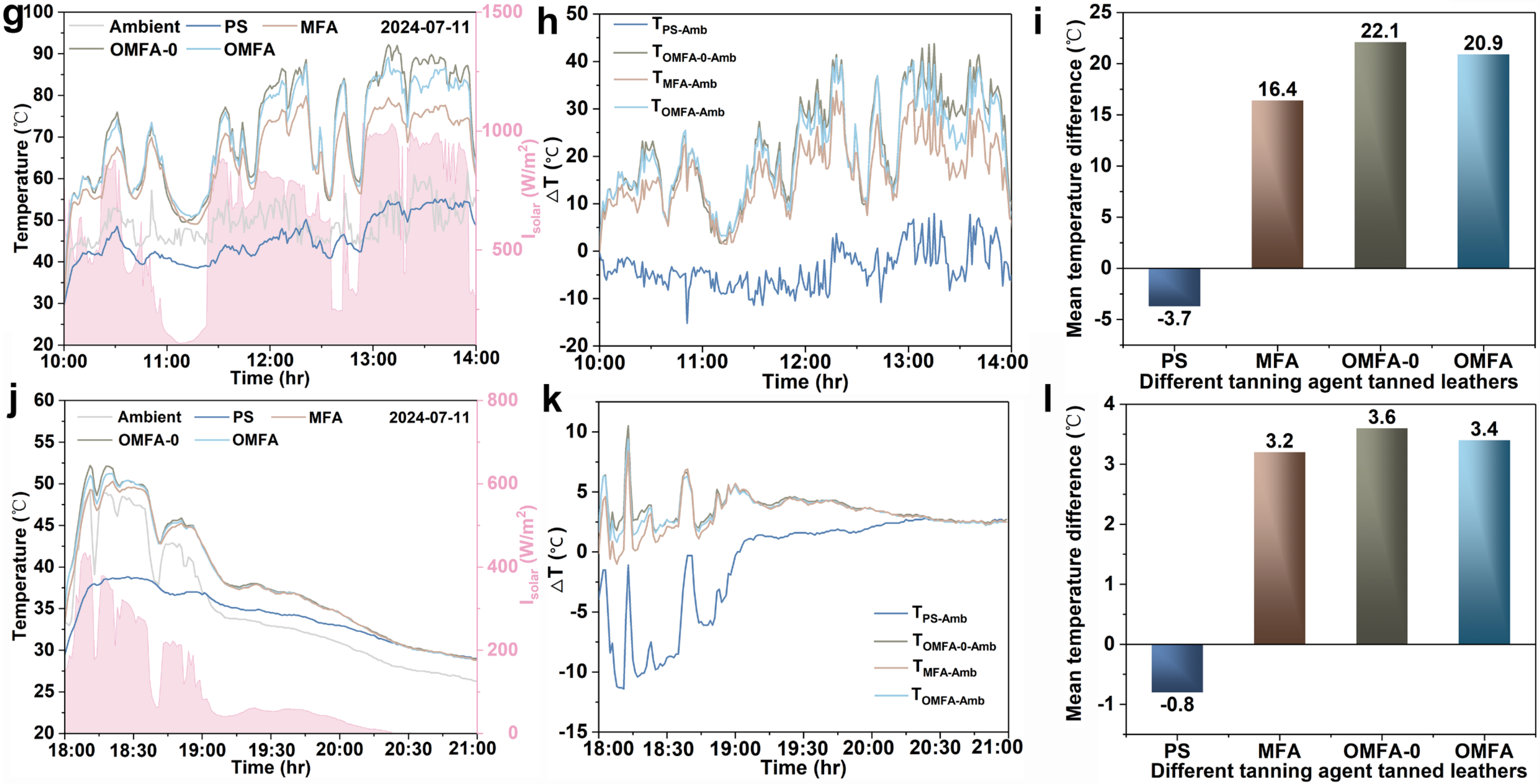
Mechanism of cross-linking



Optical Properties and Thermal Management Performance

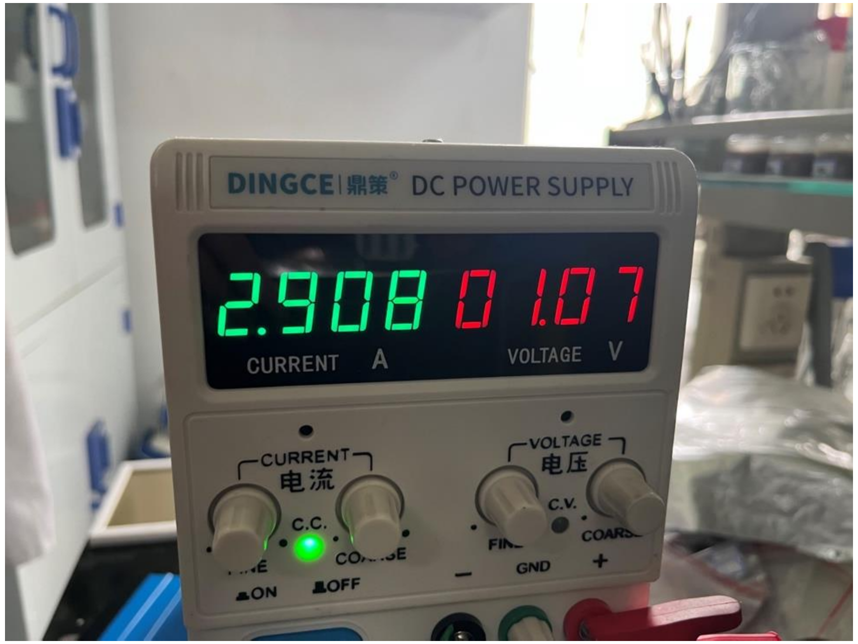


Optical Properties and Thermal Management Performance



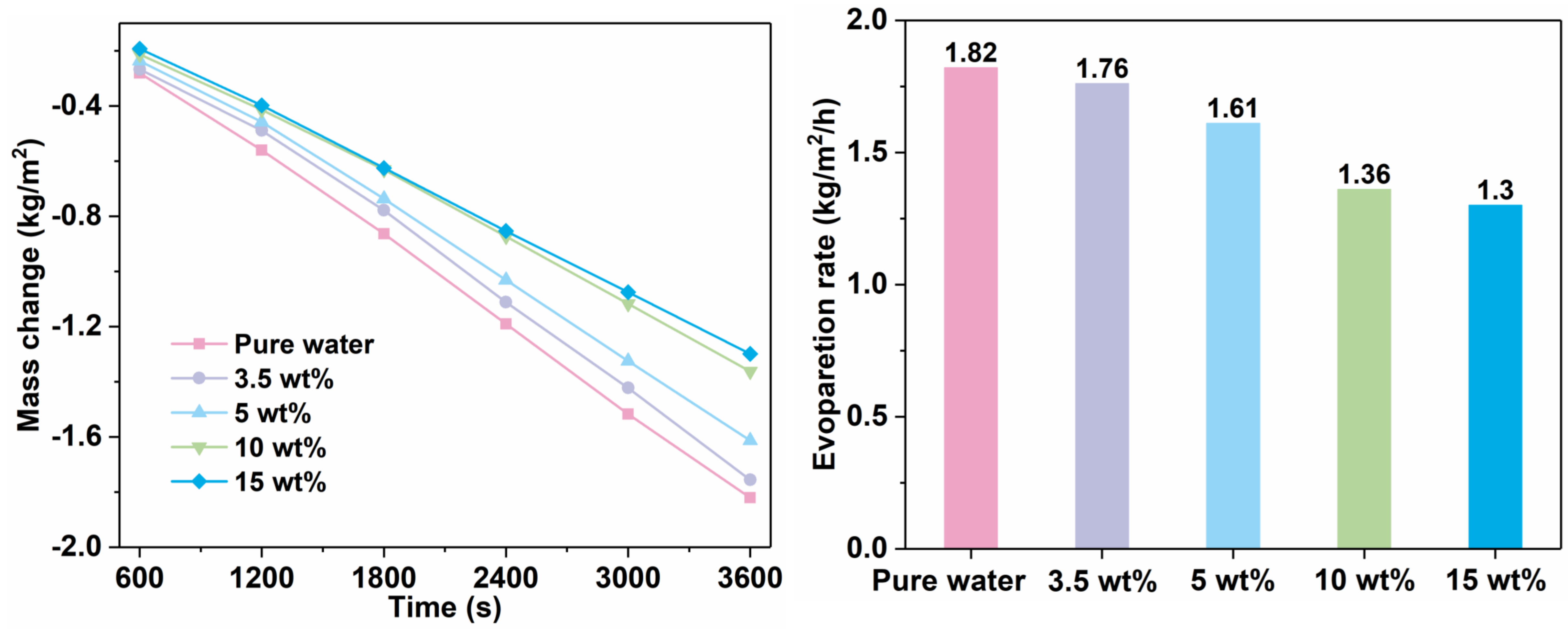
Superhydrophobic properties

Joule heating

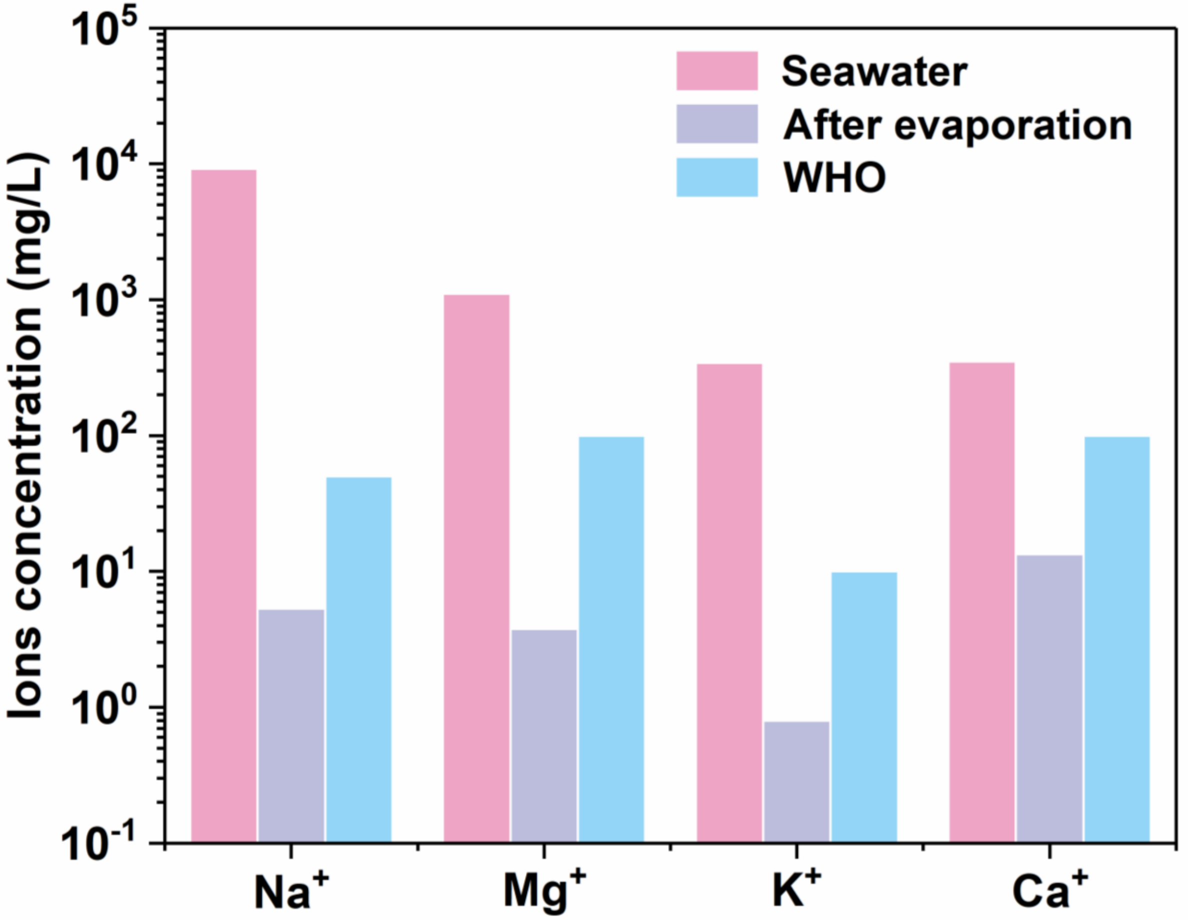


At a voltage of 1 v, it rapidly reached 74 °C for 30 s.

Seawater desalination



□ Seawater desalination



3 Conclusion

3 | Conclusion

□ Research Summary

- Our team has developed high-performance chrome-free tanning agents by systematically modifying fulvic acid via coordination, catalytic oxidation, and carbonization.
- Designing appropriate molecular size and increasing the content of active functional groups can enhance the tanning performance.
- Improve the structural defects of fulvic acid and enhance its aromaticity to enhance its photothermal conversion ability.

□ Problem

- The softness of leather tanned by fulvic acid is deficient and needs to be solved.

□ Research achievements

- Li, R.; Ren, L.; Yu, S.; Liu, H.; Sun, X.; Qiang, T. **Chem. Eng. J.** 2024, 482, 148892. https://doi.org/10.1016/j.cej.2024.148892.
- Li, R.; Ren, L.; Sun, X.; Liu, H.; Zhang, X.; Qi, B.; Yu, S.; Wei, Y.; Cheng, F.; Qiang, T. **Adv Funct Materials** 2025. https://doi.org/10.1002/adfm.202421899.
- Li, R.; Ren, L.; Qi, B.; Zhang, Y.; Sun, X.; Zhang, X.; Yu, S.; Zhang, X.; Liu, H.; Qiang, T. **Adv. Sustain. Syst.** 2025. https://doi.org/10.1002/adsu.202500839.

4 Acknowledgements

4 | Acknowledgements

- Institute of biomass and functional materials. (生物质与功能材料研究所)

- Nation Nature Science Foundation of China (22178207) and Youth Innovation Team Construction Project of Shaanxi Education Department (23JP010)……

- IULTCS Congress (2025, Lyon, France)

生物质与功能材料研究所

Institute of Biomass & Functional Materials

Thank you!

Reporter: Ruilong Li Email:liruilong0313@163.com

Advisor: Prof. Dr. Longfang Ren

Prof. Dr. Taotao Qiang