

Supporting Information

In-situ oxidized MXene ultrafiltration membrane with photocatalytic self-cleaning and antibacterial properties

Shunkai Xu^{a,b,1}, Changrong Zhao^{a,1}, Guangchao Li^{a*}, Zhou Shi, Bin Liu^{a*}

^a *Hunan Engineering Research Center of Water Security Technology and Application, College of Civil*

Engineering, Hunan University, Changsha 410082, PR China

^b *Beijing General Municipal Engineering Design & Research Institute Co.,Ltd*

., Beijing 100081, China

¹ These authors contributed equally to this work

*Corresponding author.

E-mail address: lgc_hnu@hnu.edu.cn (Guangchao Li); ahxclb@163.com (Bin Liu)

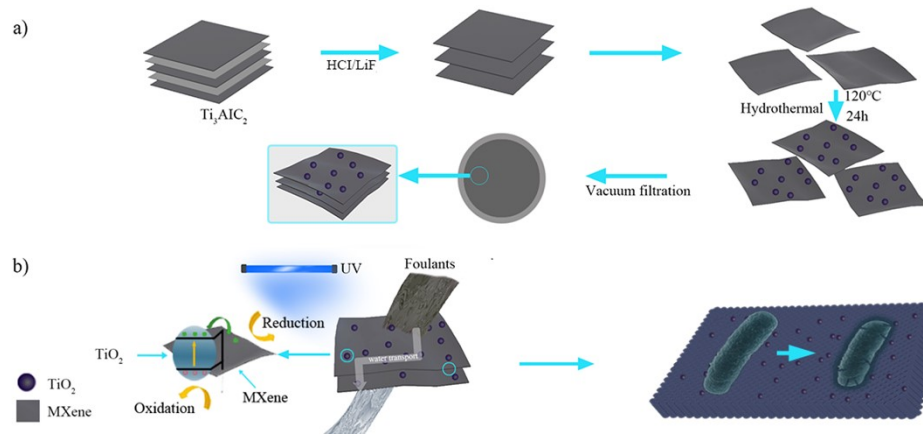


Figure S1. (a)Preparation of $\text{TiO}_2/\text{MXene}$; (b)antibacterial mechanism of $\text{TiO}_2/\text{MXene}$ membrane

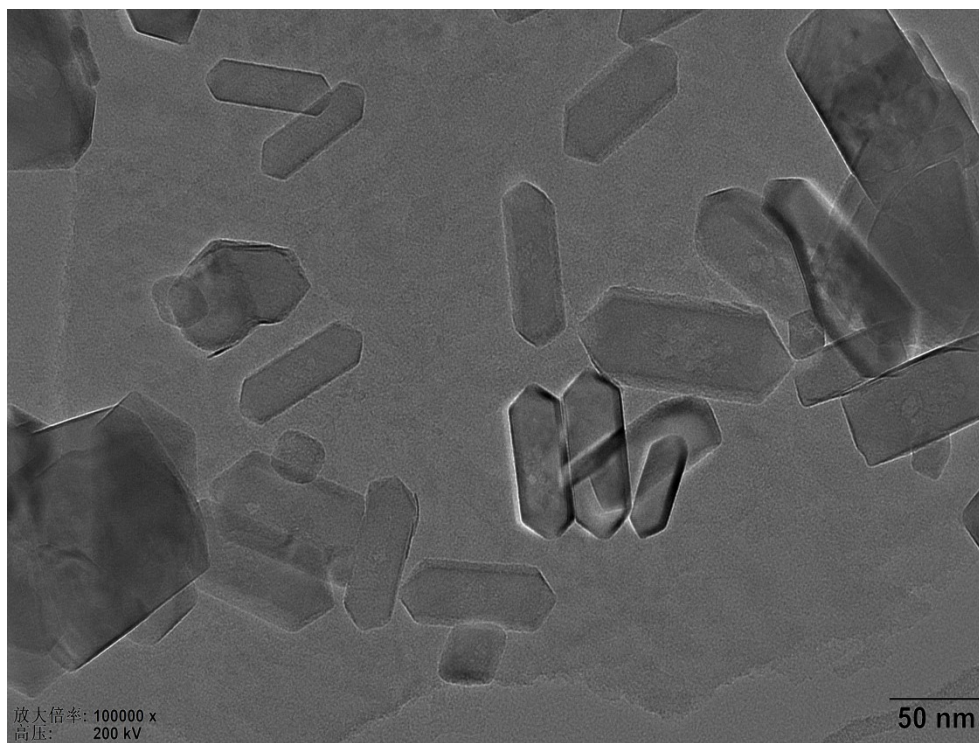


Figure S2. Tem of $\text{TiO}_2/\text{MXene}$ layer

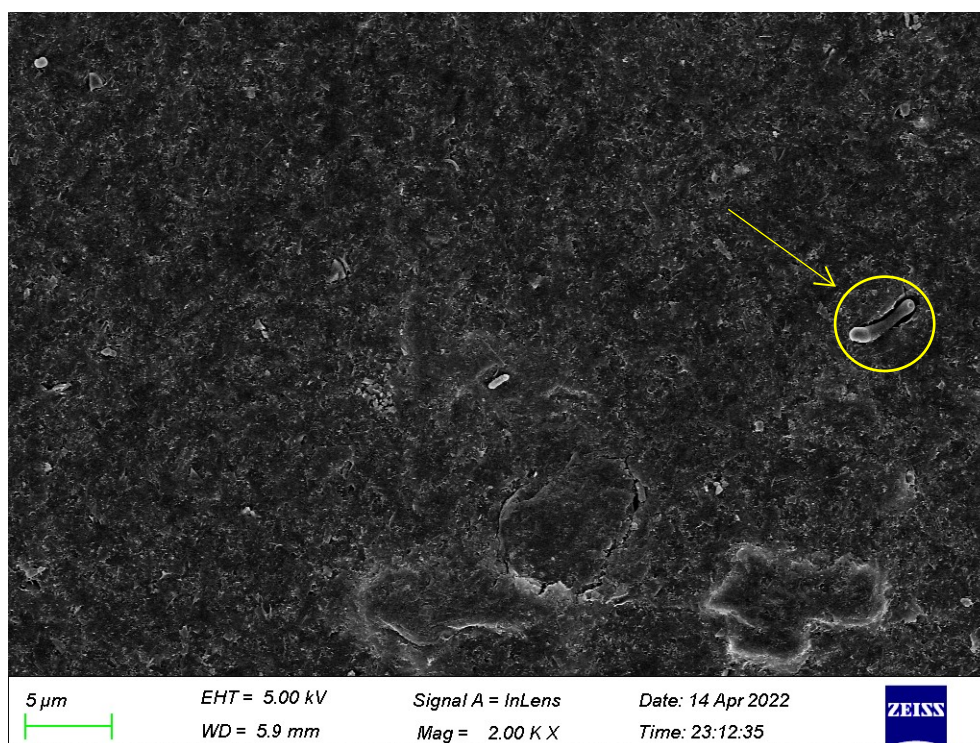


Figure S3. Surface SEM of TM-0.24 membrane

Table S1. Physicochemical parameters of membrane and adsorption free energy at h0

Membrane	Contact angle (°)			Surface tensions			Interaction energy (mJ·m ⁻²)		
	Water	Glycerol	Diiodomethane	γ^{lw}	γ^+	γ^-	ΔG^{LW}	ΔG^{AB}	ΔG^{TOT}
MXene (1mg)	80.4±0.3	64.6±0.6	20.5±0.6	47.63	0.07	3.12	-10.39	-62.17	-72.56
MXene (2mg)	80.0±0.2	70.0±0.5	49.6±0.7	34.50	0.23	6.48	-5.61	-53.78	-59.39
MXene (3mg)	76.2±0.2	70.0±0.7	55±1.0	31.45	0.25	10.63	-4.37	-47.38	-51.75
MXene (4mg)	71.5±0.3	68.2±0.9	71.5±0.3	29.44	0.37	14.99	-3.52	-41.27	-44.79
TiO ₂ /MXene(1mg)	78.8±0.1	52.9±0.9	29±0.3	44.63	1.79	1.62	-9.36	-59.02	-68.39
TiO ₂ /MXene(2mg)	78.0±0.1	53.2±0.1	28.9±1.5	44.67	1.65	1.62	-9.38	-59.39	-68.77
TiO ₂ /MXene(3mg)	72.5±0.1	57.6±0.1	28±2.1	44.22	0.45	6.25	-9.22	-52.87	-62.09
TiO ₂ /MXene(4mg)	68.9±0.7	51.1±0.9	29.3±1.5	44.51	1.15	6.56	-9.32	-49.54	-58.86
PVDF	84.9±0.4	68.5±0.1	26.7±1.3	45.53	0.05	1.87	-9.67	-66.01	-75.68

Table S2. Comparison of anti-fouling and antibacterial performance between the membranes in this study and those in the previous studies

Membrane	Feed water (g/L)	Pressure (Bar)	Flux (LMH)	FRR (%)	Antibacterial (%)	Ref.
PVDF/TiO ₂	0.5 BSA	1.0	290	46	-	1
PSF/MXene	1.0 BSA	1.0	450	76.1	-	2

PES/TiO ₂	2.0 BSA	1.0	55	46.1	-	3
PES-TiO ₂ /MXene	1.0 BSA	1.0	756.8	80.2	-	4
EPVC/TiO ₂	0.5 BSA	2.0	435	89	-	5
MoS ₂ -FeOOH	1.0 BSA	1.0	385.3	>70	-	6
PVC/ZnO-CMC	1.0 BSA	1.0	107.36	90	>90	7
HKUST-1@LCNFs	1.0 BSA	1.0	207.32	90.56	90	8
N-Si-MWNTs	1.0 BSA	1.0	173.7	96.5	95.6	9
TiO ₂ /MXene@PVD	1.0 BSA	1.0	211.5	80%	95	This work

F

References

- 1 M.H.D.A. Farahani and V. Vatanpour, *Sep. Purif. Technol.*, 2018, **197**, 372-381.
- 2 S. Zhen, C. Wei, X. Hang, Y. Wen, K. Qing, W. Ao, D. Mingmei and S. Juan, *Int. J. Env. Res. Pub. He.*, 2019, **16**.
- 3 A. Razmjou, A. Resosudarmo, R.L. Holmes, H. Li, J. Mansouri and V. Chen, *Desalination*, 2012, **287**, 271-280.
- 4 Z. Huang, Q. Zeng, Y. Liu, Y. Xu, R. Li, H. Hong, L. Shen and H. Lin, *J. Membrane Sci.*, 2021, **640**, 119854.
- 5 H. Rabiee, M.H.D.A. Farahani and V. Vatanpour, *J. Membrane Sci.*, 2014, **472**, 185-193.
- 6 M. Wang, F. Sun, H. Zeng, X. Su, G. Zhou, H. Liu and D. Xing, *Separations*, 2022, **9**.
- 7 X. Yang, X. Ma, J. Yuan, X. Feng, Y. Zhao and L. Chen, *J. Appl. Polym. Sci.*, 2023, **140**.
- 8 S. Yang, R. Tang, Y. Dai, T. Wang, Z. Zeng and L. Zhang, *Sep. Purif. Technol.*, 2021, **279**.
- 9 H. Yuan-Wei, W. Zuo-Ming, Y. Xi, C. Jun, G. Ya-Jun and L. Wan-Zhong, *J. Colloid Interf. Sci.*, 2017, **505**.