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Supporting Information: MXene Aerogel for Efficient Photothermally-Driven Membrane Distillation with Dual-Mode Antimicrobial Capability

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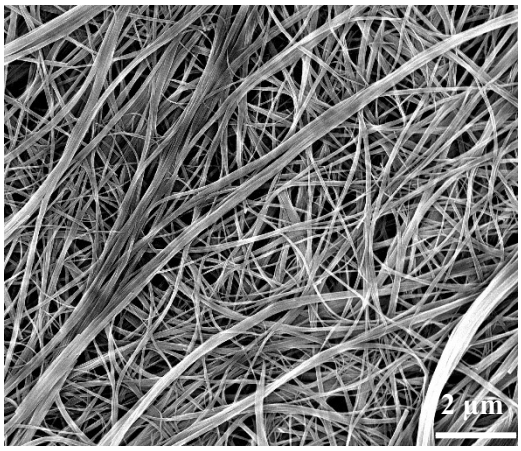

Figure S1. SEM image of HA nanowires.

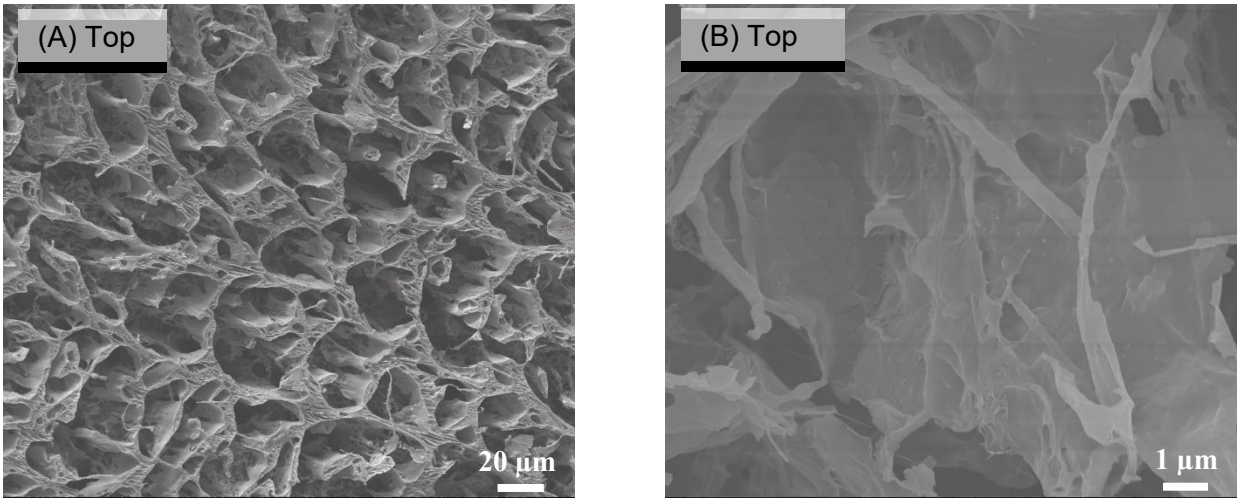

Figure S2. SEM images of FTCS-MXene/PVA/HA aerogel in low magnification (A) and high magnification.

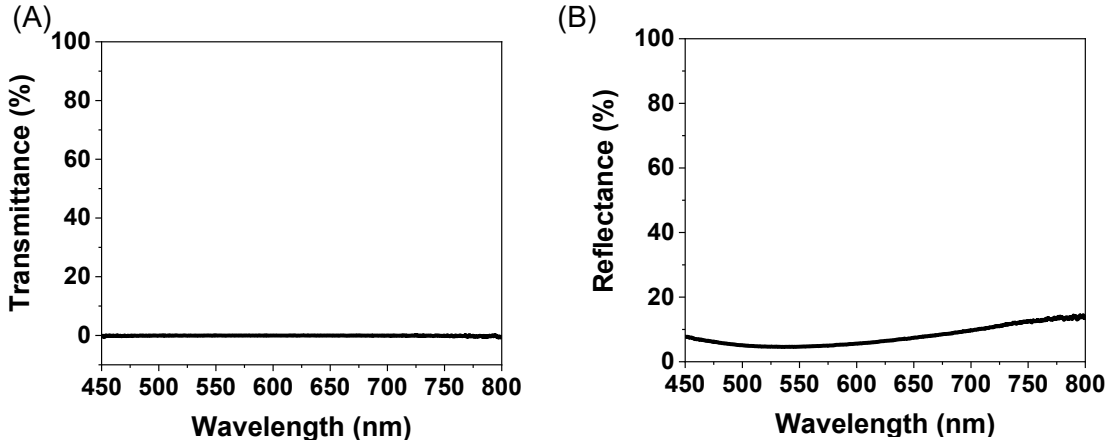

Figure S3. (A) Reflectance and (B) transmittance spectra of the compact MXene film (three different points of the sample are measured).

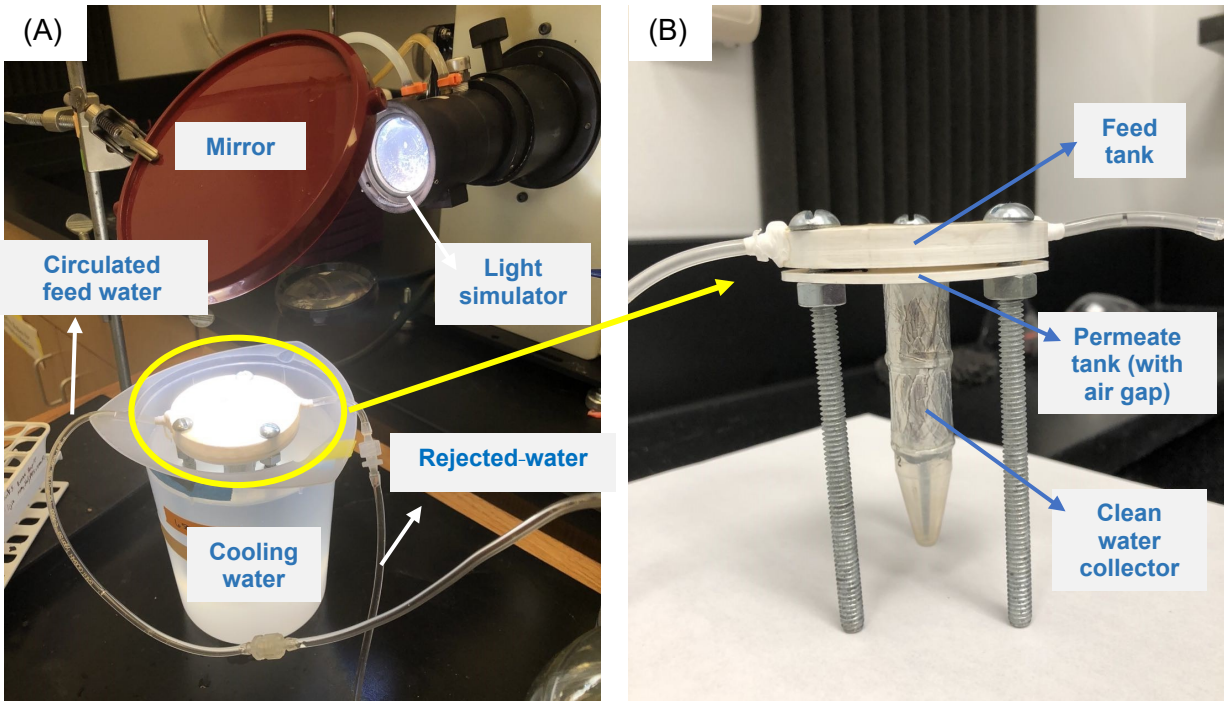

Figure S4. Photograph of (A) the PMD test system and (B) a 3D-printed AMD module. The AMD module is comprised of the feed tank and permeate tank with 2 mm air gap. Bolts and nuts are placed in the holes of the feed tank and permeate tank for fixing, respectively. NaCl solution (0.5 M) at ambient temperature is circulated at varying speeds in the feed tank. During PMD test, the feed tank is exposed to simulated sunlight. The photothermal membrane is fixed between the feed tank and permeate tank. Aluminum foil is used as the condensation surface on the permeate side. A 15 mL centrifuge tube, whose wall is cooled by ambient water, is connected to the aluminum foil to collect the condensed distillate.

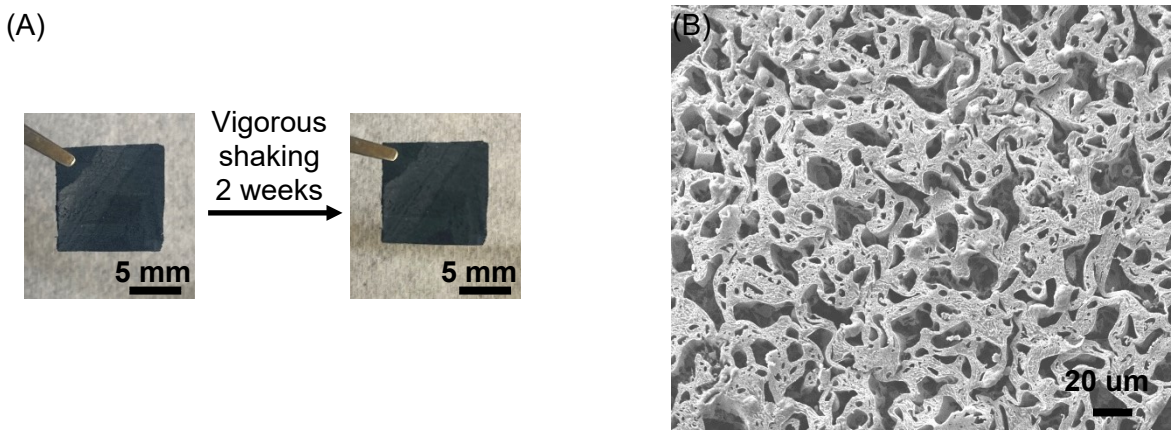

Figure S5. (A) Photographs and (B) SEM image of FTCS-MXene/PVA/HA aerogel after mechanical agitation for 2 weeks.

Table S1. Comparison of current PMD membranes and performance.

Membrane	Feed composition	Feed T (ºC)	Water retention time (min)	MD type	Irradiation (kW m^{-2})	Flux (kg m^{-2} h^{-1})	Efficiency (%)
Dye (DR1) - PTFE[1]	0.59 M NaCl	20	0	AMD*	1	0.24	16
Dye (DR1 + DB14) - PTFE[2]	Artificial seawater	20	0	AMD	1	0.78	53
Carbon Black/PVA-PVDF[3]	0.17 M NaCl	20	0.25	DCMD**	0.7	0.22	21
Carbon Black - PVDF[4]	0.17 M NaCl	35	0.02	DCMD	1.367	0.79-1.51	40-75
Ag NPs-PVDF[5]	0.5 M NaCl	30	NA	VMD***	23.2 (UV)	25.7	29
FTCS-PDA-PVDF[6]	0.5 M NaCl	20	4.36	DCMD	0.75	0.49	45
rGO/pDA-PTFE[7]	DI water	20	0	AMD	1	0.72	49
MXene-PVDF[8]	0.17 M NaCl	65	0.06	DCMD	7	1	10
Commercial absorber (cermetcoated aluminum	0.6 M NaCl	20	0	AMD	1	0.73	51

alloy substrate)-PVDF-HFP (1 layer) [9]							
FTCS-CB-PVDF[10]	Natural seawater collected from the Hainan Island	20	0.13	DCMD	1	0.78	55
PEDOT-PSS-graphene–nickel foam[11]	Natural seawater from Hainan Island	20	0	AMD	1	1.1	73****
CNT-carbonized eggshell - PVDF[12]	0.6 M NaCl	20	NA	DCMD	1	1.11	76****
FTCS-PDA-HA[13]	0.5 M NaCl	20	1.57	DCMD	1	0.89	62*****
PDMS/CNT/PVDF (1 layer) [14]	0.6 M NaCl	30-35	0	AMD	1	0.9	60
Fe_3O_4/PVDF-HFP[15]	0.6 M NaCl	26	NA	DCMD	1	0.97	53
TiN-PVA-PVDF[16]	0.6 M NaCl	26	0	AMD	1	0.94	64****
FTCS-PDA/BNC[1]	0.5 M NaCl	20	4.36	DCMD	1	1	68*****

[7]							
This work	0.5 M NaCl	20	2	AMD	0.8	0.72	61

*AMD: air gap membrane distillation.

**DCMD: direct contact membrane distillation.

***VMD: vacuum membrane distillation.

******Three references reported higher efficiencies than our work, but their water retention time were either zero or not specified.

*******The thermal efficiency of our membrane is comparable with recently reported highly efficient photothermal membranes among PMD systems with similar irradiation, water retention time, and feed water temperatures.

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