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# Supporting Information

# MXene-decorated flexible $Al_2O_3/TiO_2$ nanofibrous mats with self-adaptive stress dispersion towards multifunctional desalination

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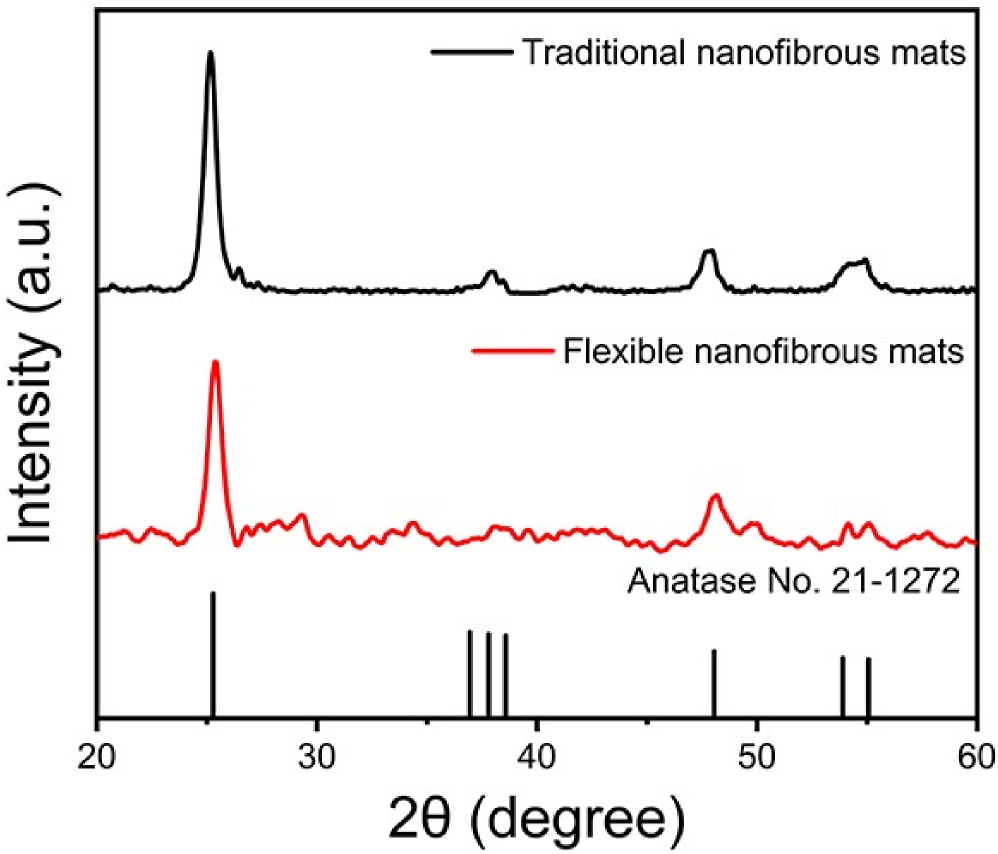


**Fig. S1.** XRD of flexible and traditional $Al_2O_3/TiO_2$ nanofibrous mats.

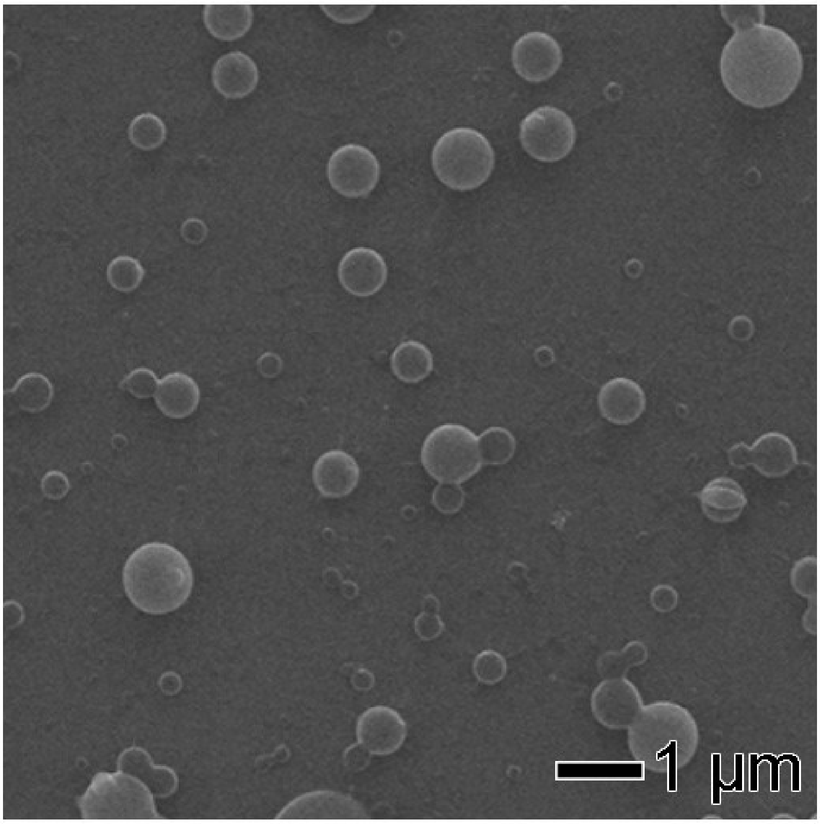


**Fig. S2.** SEM image of the $Al_2O_3/TiO_2$ microspheres.

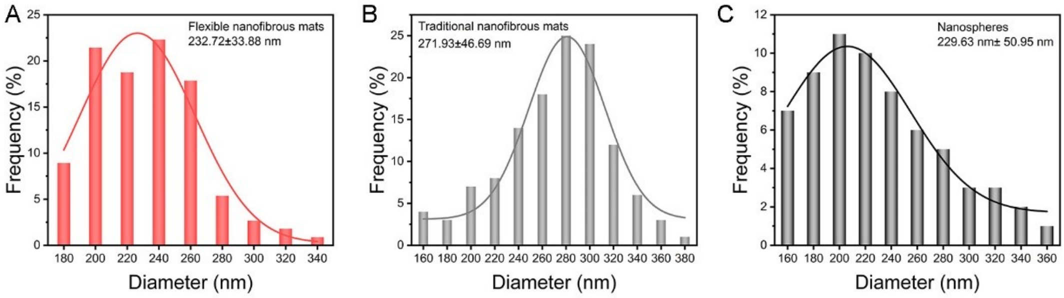


**Fig. S3.** The corresponding diameter distributions of (A) flexible, (B) traditional $Al_2O_3/TiO_2$ nanofibrous mat and (C) $Al_2O_3/TiO_2$ nanospheres.

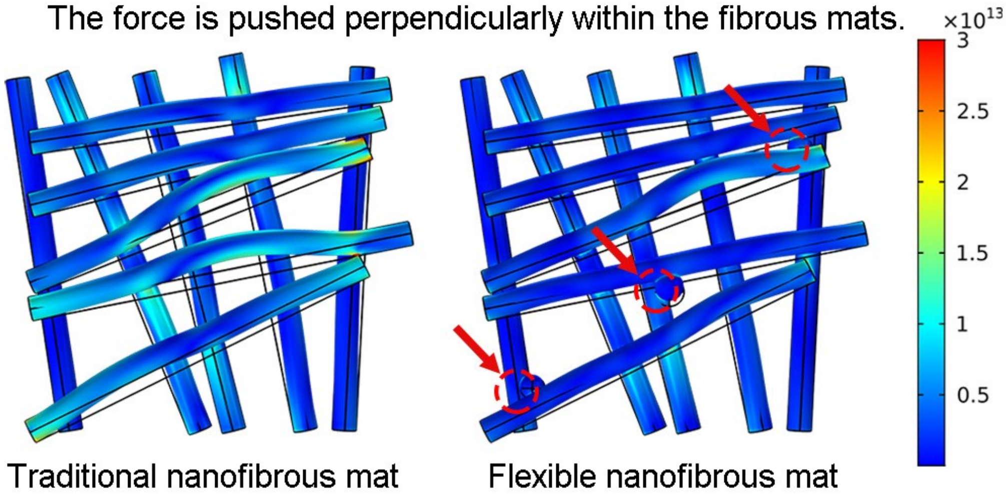


**Fig. S4.** Elastic modulus of the traditional nanofibrous mat and flexible nanofibrous mat.

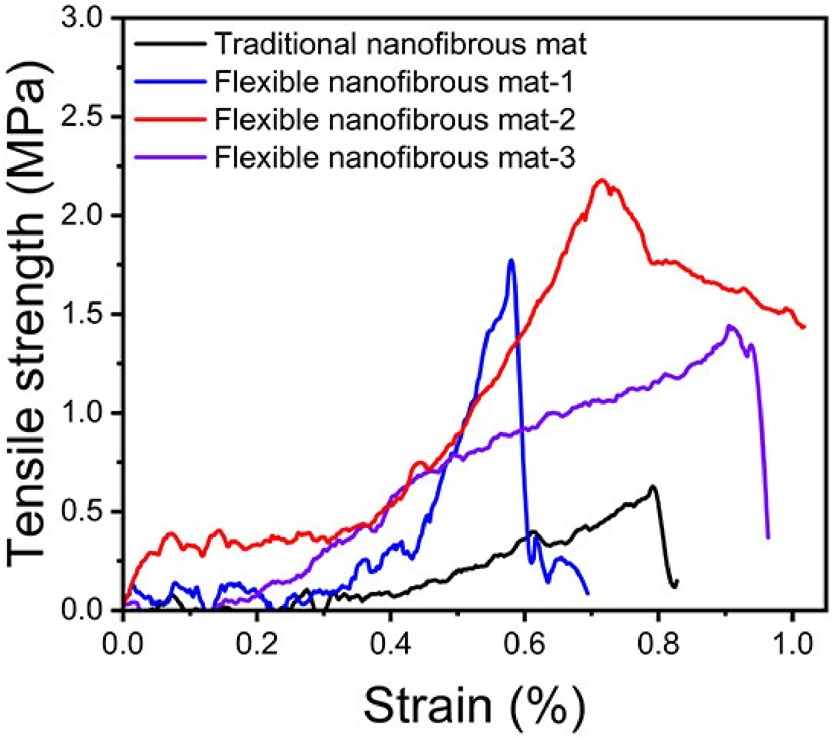


**Fig. S5.** The stress-strain curves of traditional and flexible $Al_2O_3/TiO_2$ nanofibrous mats.

**Table S1** Comparison of tensile strength

| Materials | Tensile strength /MPa | Strain/% | Young's modulus/MPa | Reference |
|---|---|---|---|---|
| **Flexible Sn-doped $SrTiO_3$ membranes** | 0.220 | 1.80 | 13.3 | [1] |
| **BM-$Li_{0.35}La_{0.55}TiO_3$ membrane** | 0.320 | 1.58 | 20.3 | [2] |
| **N-CNF membrane** | 0.880 | 1.69 | 51.8 | [3] |
| **$TiO_2$/carbon NFM** | 1.14 | 2.20 | 51.8 | [4] |
| **Co-doped-core-shell carbon NFM** | 1.30 | 3.50 | 37.1 | [5] |
| **$SiO_2$-CNFMs** | 1.52 | 1.77 | 77.4 | [6] |
| **Montmorillonite@$ZrO_2$-$SiO_2$ membranes** | 1.83 | 1.13 | 146 | [7] |
| **Flexible $Al_2O_3$/$TiO_2$ nanofibrous mat-1** | 1.77 | 0.581 | 305 | This work |
| **Flexible $Al_2O_3$/$TiO_2$ nanofibrous mat-2** | 2.18 | 0.715 | 305 | This work |
| **Flexible $Al_2O_3$/$TiO_2$ nanofibrous mat-3** | 1.44 | 0.905 | 159 | This work |

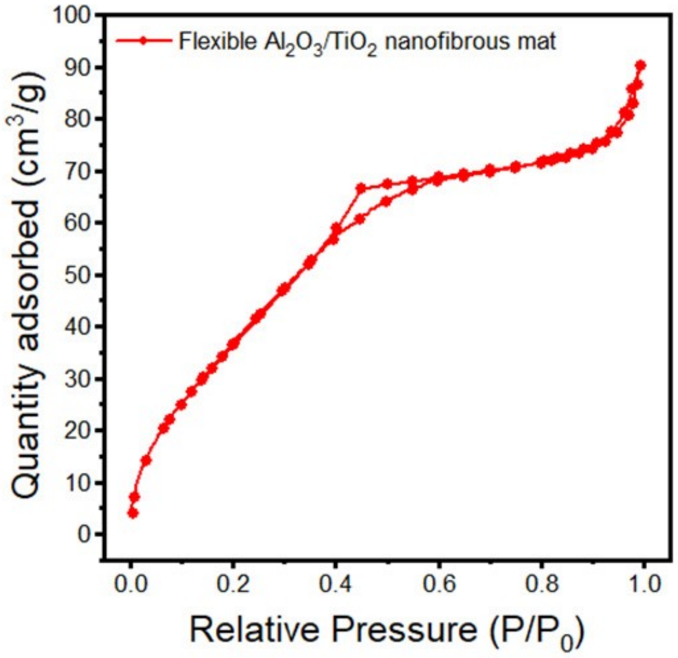


**Fig. S6.** BJH adsorption of traditional and flexible $Al_2O_3/TiO_2$ nanofibrous mats.

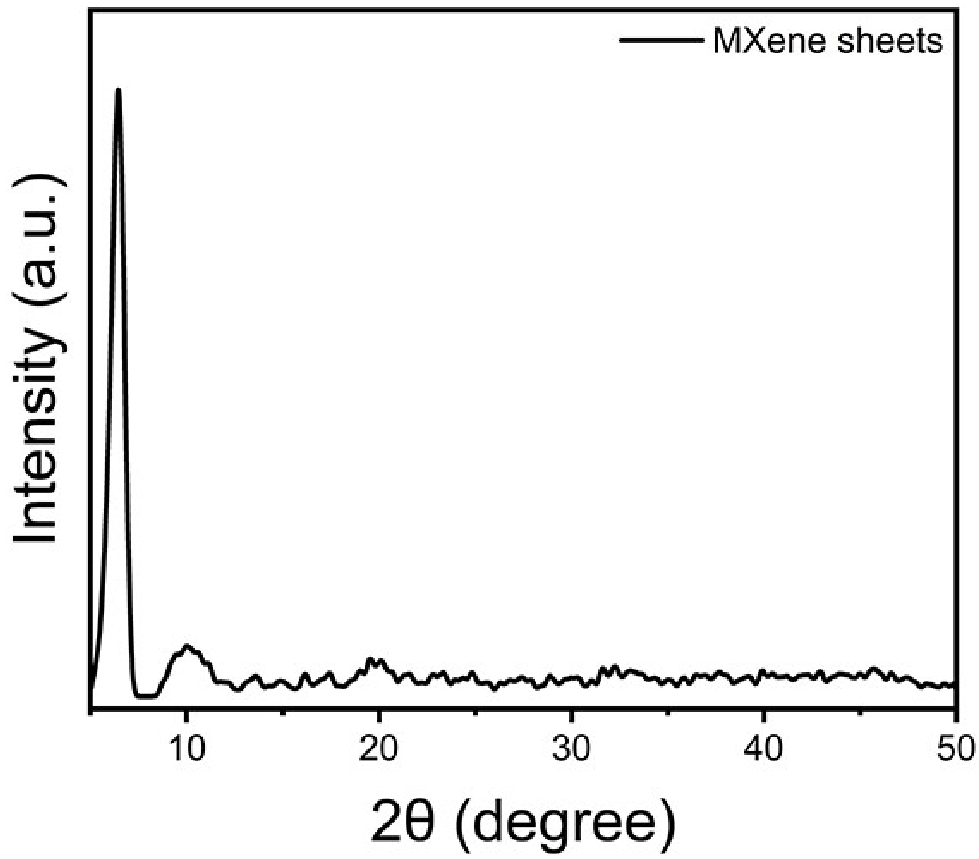


**Fig. S7.** XRD of the $Ti_3C_2T_x$ Mxene sheets.

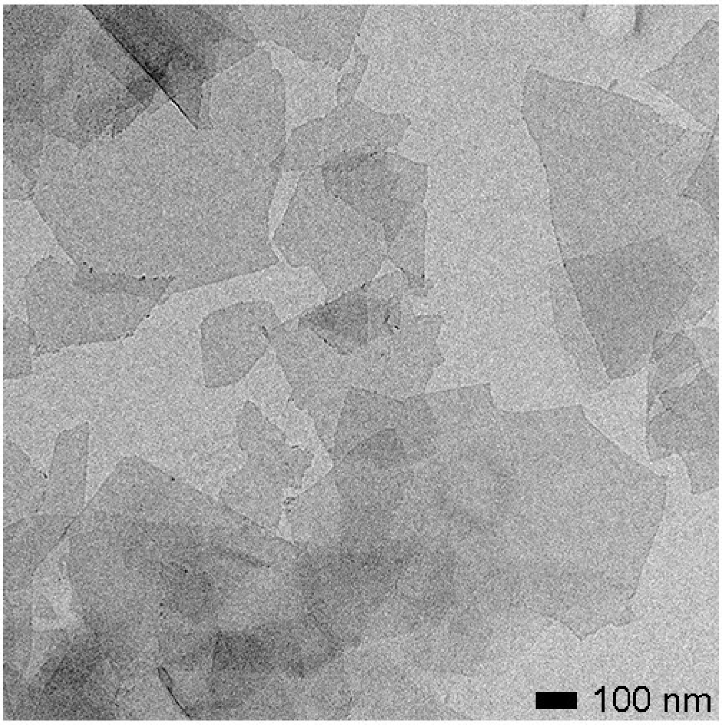


**Fig. S8.** TEM image of the $Ti_3C_2T_x$ Mxene sheets.

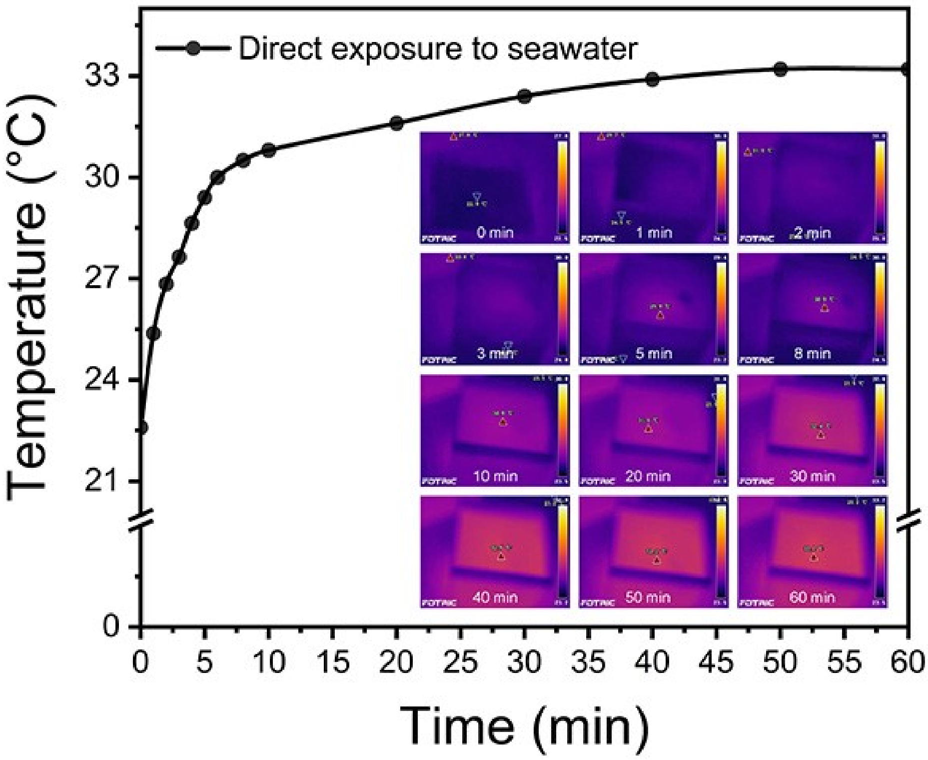


**Fig. S9.** Surface temperature change as a function of irradiation time for the water under one sun solar illumination. The inset depicts the IR thermal images showing the temperature distribution of the water.

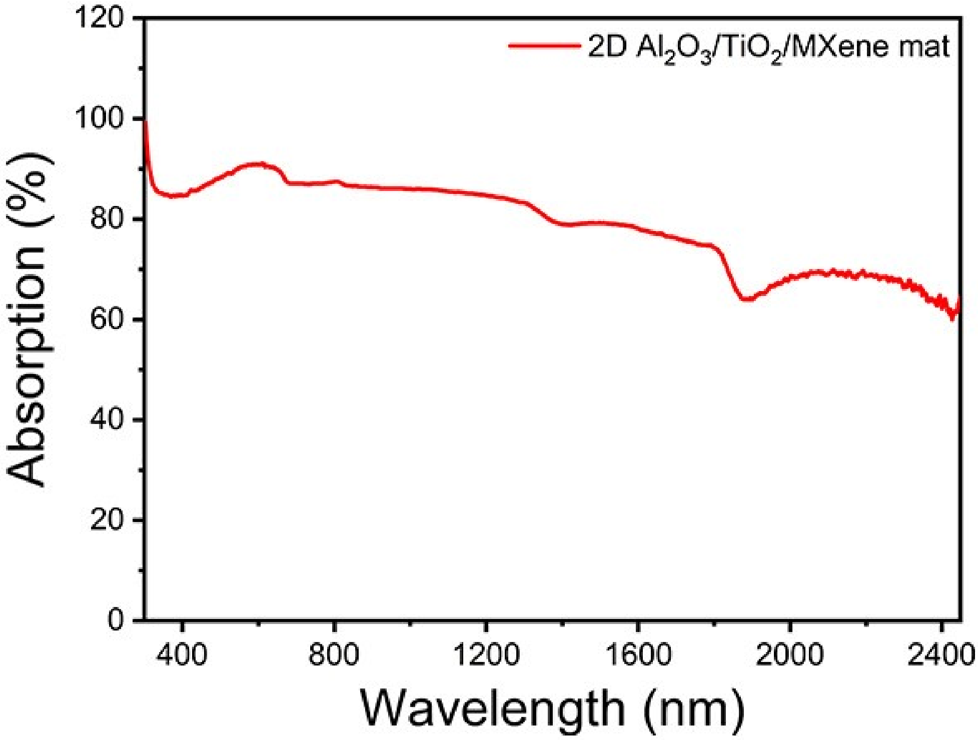


**Fig. S10.** Absorption spectra of the $Al_2O_3/TiO_2$/MXene mat.

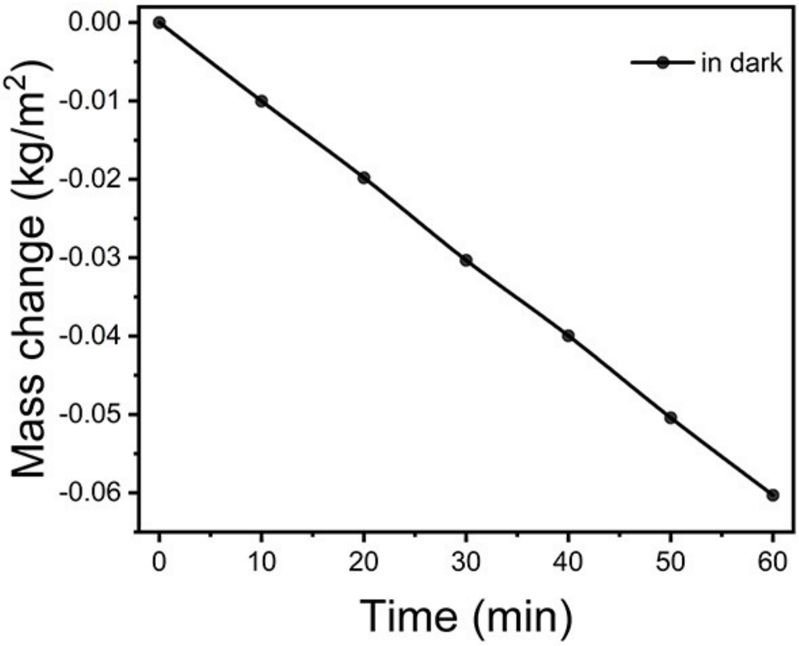


**Fig. S11.** The water mass change recording the evaporation performance of photothermal $Al_2O_3/TiO_2$/Mxene mat under dark.

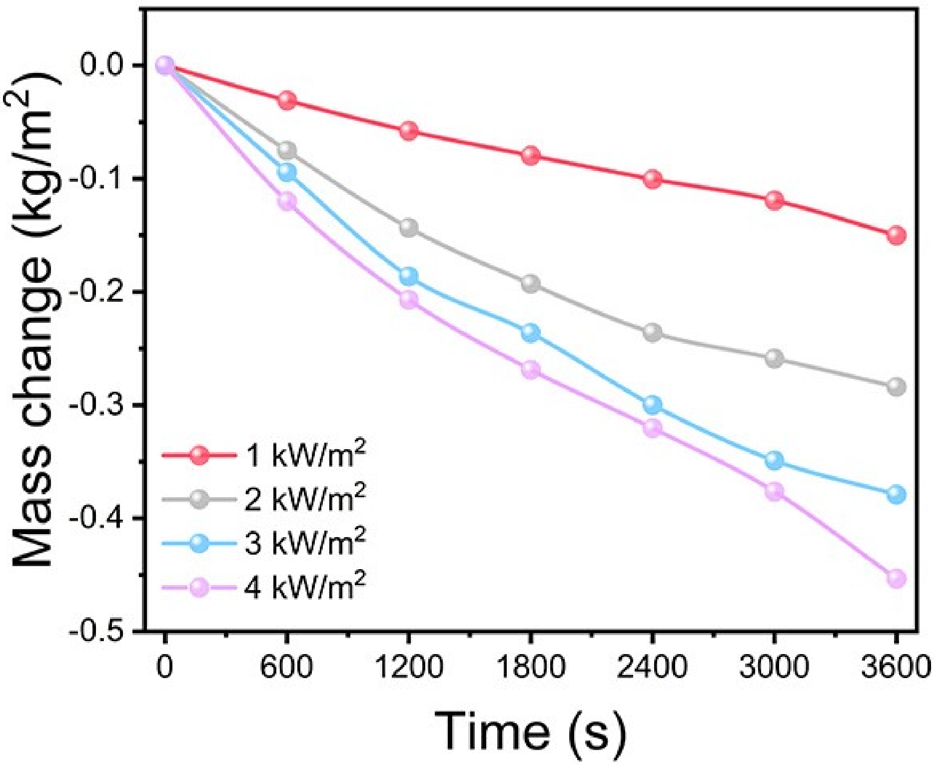


**Fig. S12.** Mass change of seawater for the flexible $Al_2O_3/TiO_2$ mat under different solar illumination intensities.

**Table S3** Comparison of conversion rates in Figure. 3

| Materials | evaporation rate ($kg \cdot m^{-2} \cdot h^{-1}$) | light-to-vapor energy conversion efficiency (%) | Reference |
| --- | --- | --- | --- |
| A cobalt nanoparticle-carbonaceous nanosheets/MXene foam | 1.39 | 93.4 | [8] |
| Flexible and superhydrophobic MXene based fabric composites | 1.26 | 93.3 | [9] |
| Nanocomposite MXene@rGO membrane | 1.33 | 85.2 | [10] |
| PVDF/graphene membrane | 1.20 | 84.0 | [11] |
| Graphite-wood | 1.15 | 80.0 | [12] |
| A metal-Si hybrid nanowire | 1.12 | 72.8 | [13] |
| Carbon black nanoparticles of Janus absorbers | 1.30 | 72.0 | [14] |
| Photothermal $Al_2O_3/TiO_2$/Mxene mat | 1.43 | 102 | this work |

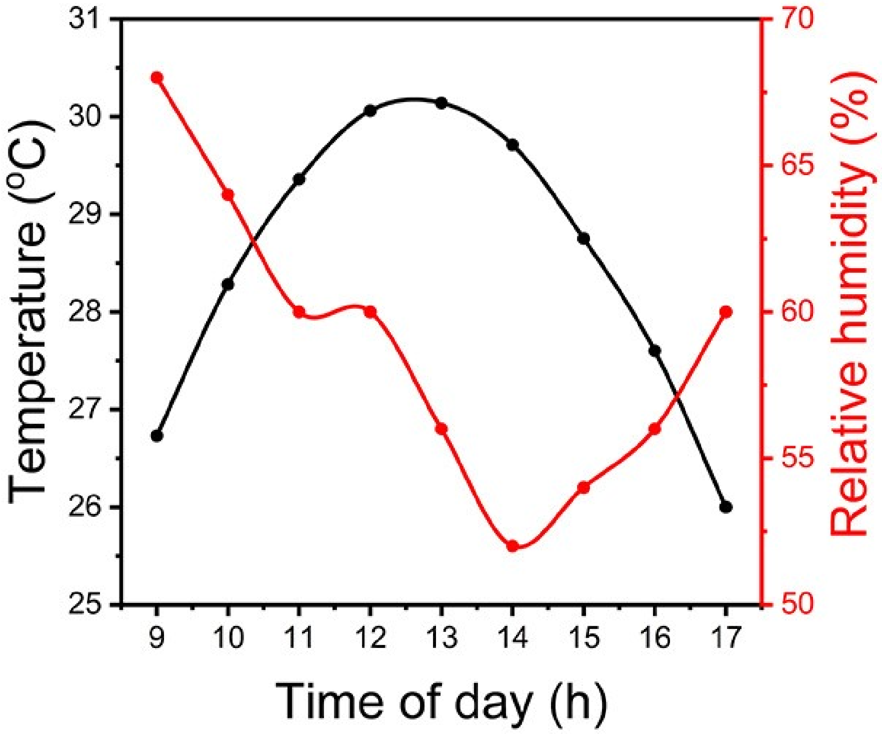


**Fig. S13.** Air temperature and relative humidity were recorded from 9:00 to 17:00.

**Table S3** Comparison of density of the 3D photothermal evaporator to previous reports in Figure. 5

| Materials | Density ($mg/cm^3$) | Reference |
| --- | --- | --- |
| Elastic 3D fibrous aerogels | 7.02 | [15] |
| Porous 3D nanofibrous Kevlar aeroge | 11.9 | [16] |
| Ultralight BNNTs/rGO aerogel | 16.3 | [17] |
| Self-assembled 3D networks of aramid nanofiber composites | 20.0 | [18] |
| Aramid nanofiber aerogel | 25.0 | [19] |
| ANF-derived carbon aerogel | 51.7 | [20] |
| Polyimide/MXene aerogel | 69.7 | [21] |
| Resultant graphene-polydopamine-bovine serum albumin aerogel | 88.0 | [22] |
| 3D $Al_2O_3/TiO_2$/Mxene evaporator | 6.41 | This work |

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