Supporting Information for

Bifunctional MoS_2-based solar evaporator for both efficient water evaporation and clean freshwater collection

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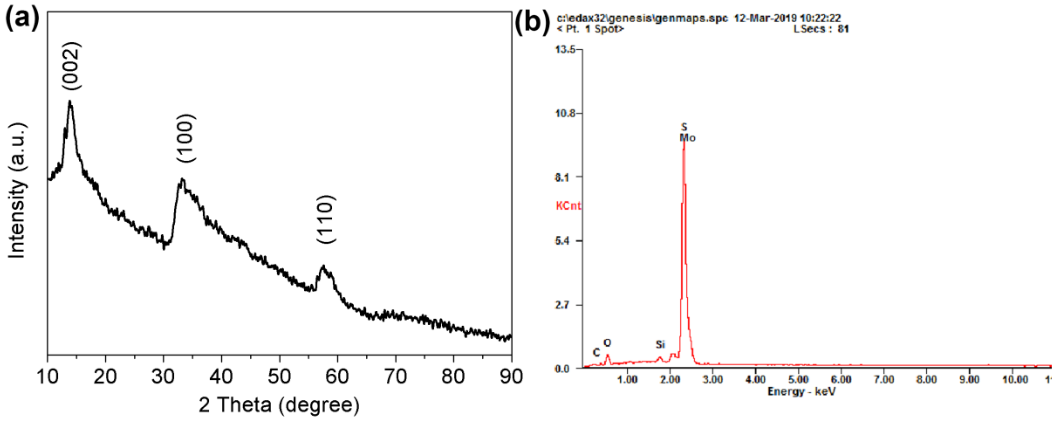

Fig. S1 XRD pattern and EDS of the as-prepared MoS_2 nanoflowers.

Fig. S2 Air-laid paper (a) without and with (b) 0.004 $kg \cdot m^{-2}$, (c) 0.016 $kg \cdot m^{-2}$, (d) 0.040 $kg \cdot m^{-2}$, (e) 0.080 $kg \cdot m^{-2}$, (f) 0.160 $kg \cdot m^{-2}$ MoS_2 deposition.

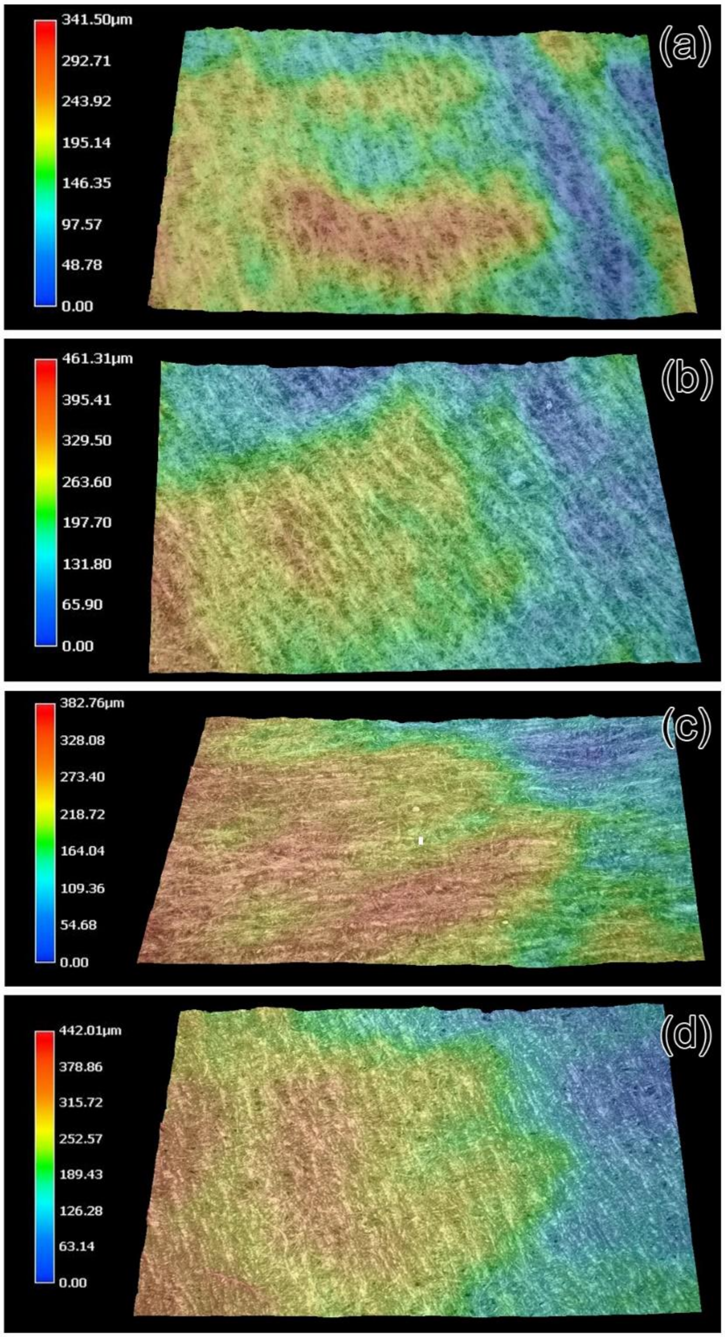

Fig. S3 The 3D optical microscope images of air-laid paper with (a) 0.004 kg·m^{-2}, (b) 0.016 kg·m^{-2}, (c) 0.080 kg·m^{-2}, and (d) 0.160 kg·m^{-2} MoS_2 nanoflowers deposition.

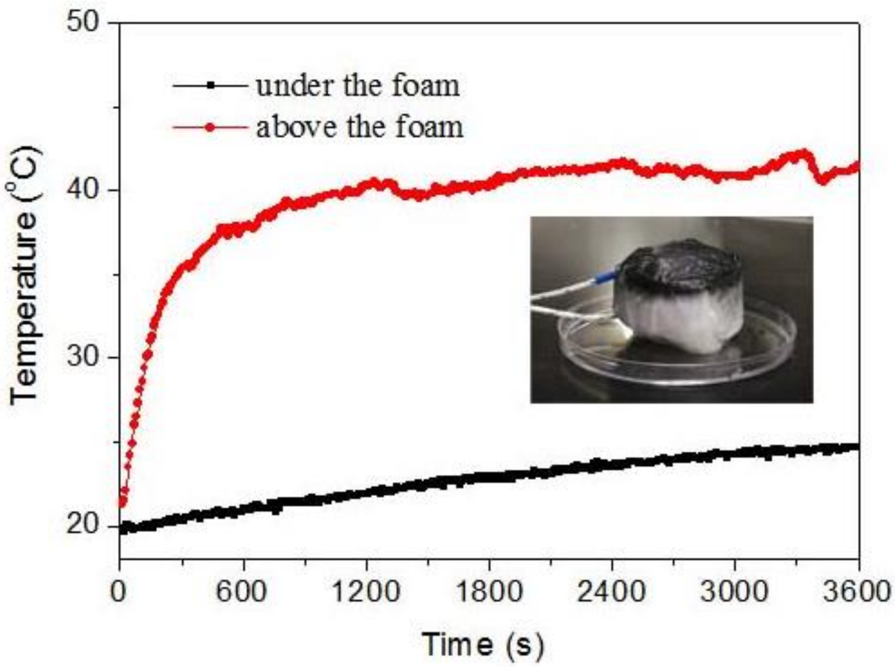

Fig. S4 The temperature above and below the foam under 2 sun solar irradiance.

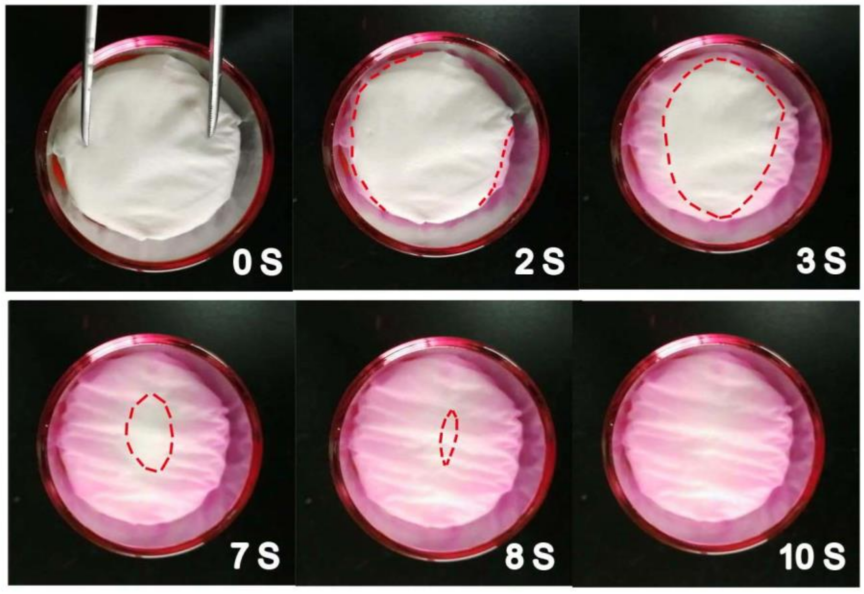

Fig. S5 Water-uptake behavior of the EPE foam warped with air-laid paper (EPE-ALP).

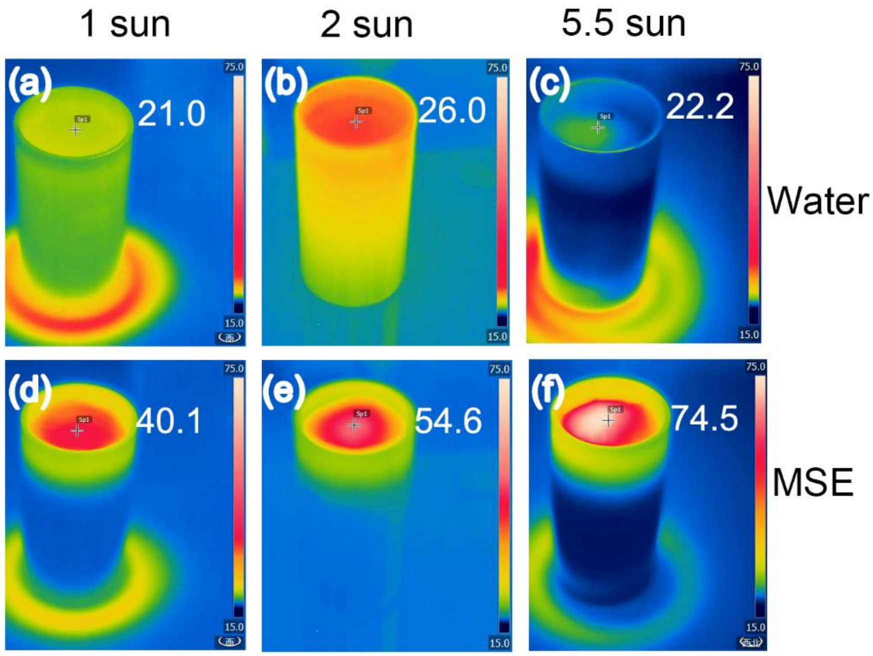

Fig. S6 The surface temperatures at first 5 minutes solar irradiance with and without MSE under different intensity of 1, 2, and 5.5 sun.

Table S1 The proportion of solar absorption of different samples in different spectrum regions.

Sample	MoS_2 ($kg\cdot m^{-2}$)	Total Absorption	UV 280-400 nm	Visible 400-760 nm	Infrared 760-2200 nm
Solar	_	100.00%	4.45%	49.37%	46.18%
ALP	0	3.68%±0.08%	1.08%±0.06%	1.54%±0.01%	1.06%±0.03%
Sample-1	0.004	82.66%±0.07%	3.72%±0.04%	40.82%±0.40%	38.12%±0.36%
Sample-2	0.016	95.39%±0.08%	4.21%±0.01%	46.91%±0.17%	44.27%±0.16%
Sample-3	0.040	96.64%±0.13%	4.24%±0.04%	47.72%±0.07%	44.68%±0.06%
Sample-4	0.080	96.02%±0.70%	4.28%±0.25%	47.26%±0.39%	44.48%±0.21%
Sample-5	0.160	96.15%±0.53%	4.22%±0.11%	46.72%±0.98%	45.21%±0.78%

*ALP: Air-laid paper

Table S2 The zero-order kinetic equations and evaporation efficiencies of different water evaporation processes.

Process	Zero-order kinetic equations	k_1 ($kg\cdot m^{-2}\cdot min^{-1}$)	k_2 ($kg\cdot m^{-2}\cdot h^{-1}$)	R^2
1#	y=0.00602x-0.02363	0.00602	0.36	0.98106
2#	y=0.02531x-0.02910	0.02531	1.52	0.99905
3#	y=0.00731x-0.01341	0.00731	0.44	0.99764
4#	y=0.01091x-0.03367	0.01091	0.65	0.99311

* k_1: water evaporation rate; k_2: water evaporation rate;
Water evaporation under two sun solar irradiation by different processes:
(1#) water itself evaporation
(2#) MSE with 0.04 $kg\cdot m^2$ of MoS_2 and 2 cm of EPE foam
(3#) air-laid paper wrapped over the 2 cm of EPE foam (paper-foam)
(4#) 0.04 $kg\cdot m^2$ of hydrophobic MoS_2 directly float on water surface

Table S3 The vapor pressure and Henry's constant of three compounds.

Compound	Molecular Formula	Vapor Pressure mm Hg at 25 °C (est)	Henry's constant atm-m^3/mole
Nitrobenzene	$C_6H_5NO_2$	0.245 (PubChem)	2.44×10^{-5} (PubChem)
Carbamazepine	$C_{15}H_{12}N_2O$	1.84×10^{-7} [1]	1.08×10^{-10} (PubChem)
Naproxen	$C_{14}H_{14}O_3$	1.89×10^{-6} (PubChem)	3.39×10^{-10} (PubChem)

Energy balance analysis:

According to previous report of J. Zhu's group and Qu's group [2,3], the main energy consumption under input heat flux of 1 kW·m^{-2} could be caused by the approach as follows:

(1) Water evaporation consumption (η):

The water evaporation consumption is 80%, which is equal to the evaporation efficiency.

(2) Refection loss (η_{ref}):

The solar absorption of black wood membrane is up to 96.64%. Thus, η_{ref} is about 3.36%.

(3) Conduction loss (η_{cond}):

$$\eta_{cond} = Cm\Delta T \quad (1)$$

Where η_{cond} is the heat energy, C is the specific heat capacity of water (4.2 kJ $^{o}C^{-1}$

kg^{-1}), m (140 g) is the weight of pure water used in this experiment. ΔT (0.08 °C) is the average temperature difference of pure water after and before solar illumination under 1 sun after 1 h. The conduction loss is calculated ~4.7%.

(4) Radiation loss ($\boldsymbol{\eta_{rad}}$):

The radiation heat loss was calculated by the Stefan-Boltzmann equation.

$$\boldsymbol{\eta_{rad}} = \varepsilon A\sigma(T_1^4 - T_2^4) \qquad (2)$$

Where $\boldsymbol{\eta_{rad}}$ represents heat flux, ε is the emissivity(assumed a maximum emissivity of 1), and A is the surface area, σ is the Stefan-Boltzmann constant (5.67×10^{-8} W/ m^2 K^4), T_1 is the average surface temperature (≈ 314.15 K) of MSE at a steady state condition, and T_2 is the ambient temperature (≈308.15 K) upward the MSE under the illumination of constant 1 kW m^2 solar flux. According to the equation (2), the radiation heat loss is calculated ~6.52%.

(5) Convection loss ($\boldsymbol{\eta_{conv}}$):

$$\boldsymbol{\eta}_{\mathrm{conv}} = hA(T_1 - T_2) \qquad (3)$$

Where $\boldsymbol{\eta}_{\mathrm{conv}}$ represents heat energy, h is the convection heat transfer coefficient (assumed to 5 W m^{-2} K as reported [4]), and A is the surface area, T_1 and T_2 are the same as mentioned above. The $\boldsymbol{\eta_{conv}}$ is 4.77%.

Therefore, the total energy consumption of the five main parts is about 99.35% (80% + 3.36% + 4.70% + 6.52% + 4.77%≈99.35%), which is almost all input energy.

References

[1] PubChem, U.S. National Library of Medicine. Available online at: https://pubchem.ncbi.nlm.nih.gov/search/

[2] N. Xu, X. Hu, W. Xu, X. Li, L. Zhou, S. Zhu and J. Zhu, *Adv. Mater.*, 2017, 29,1606762.

[3] P. Zhang, Q. Liao, T. Zhang, H. Cheng, Y. Huang, C. Yang, C. Li, L. Jiang and L. Qu, *Nano Energy*, 2018, **46**, 415-422.

[4] Y. Yang, H. Zhao, Z. Yin, J. Zhao, X. Yin, N. Li, D. Yin, Y. Li, B. Lei, Y. Du and W. Que, *Materials Horizons*, 2018, **5**, 1143-1150.