

Supplementary material

Full-spectrum flatband photothermal evaporator with superhydrophilic vertical nanochannels for efficient solar steam generation

Jinbu Su*, Weixin Du, Chenyi Shi, Xuli Lin, Xinyu Dong, Xingxu Miao, Zifen Guo, Chengbing Wang*

School of Material Science and Engineering, Shaanxi Key Laboratory of Green Preparation and Functionalization for Inorganic Materials, Shaanxi University of Science and Technology, Xi'an, 710021, China

Corresponding Author: sujinbu@sust.edu.cn, wangcb@sust.edu.cn

Supplementary Notes.

Note S1. Equivalent evaporation enthalpy of water in BTT.

DSC measurements were performed to investigate the heat flow signal of water evaporation from T_1 (25°C) to T_2 (200°C) under the set nitrogen flow rate. During the enthalpy test, the samples were placed in an aluminum crucible with a lid and evaporated at a balanced scan rate (5 K min⁻¹), using air as a reference. The sample's heat flow signal was recorded as a function of temperature and time. The difference in water evaporation between the two systems can be clearly observed in the heat flow and temperature curves, and the equivalent evaporation enthalpy (1686 J g⁻¹) of water in BTT can be calculated by normalizing the heat flow and time curves.

Supplementary Figures.

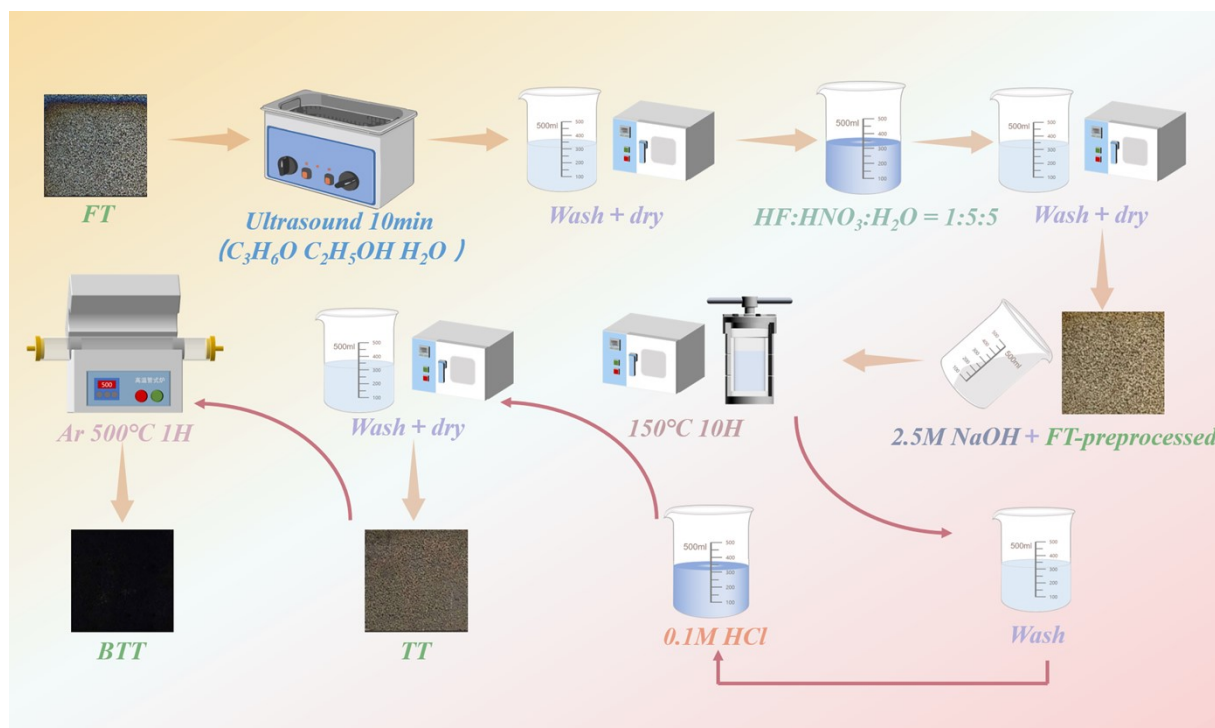


Figure S1. The preparation flow chart of BTT evaporator.

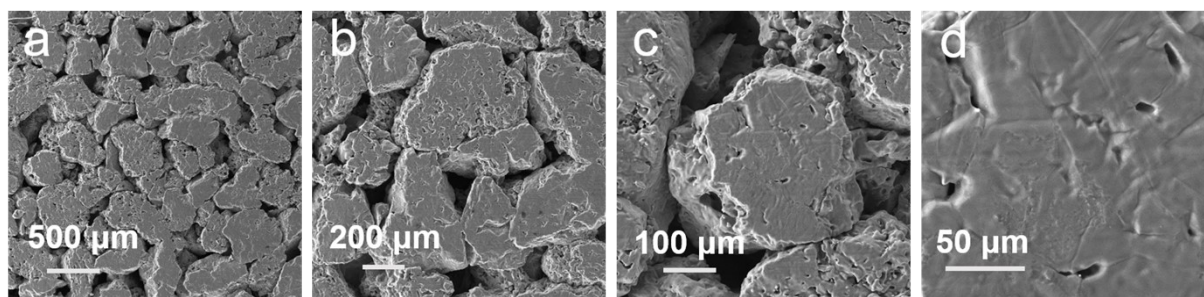


Figure S2. SEM images of the FT. SEM images demonstrate that the surface of the FT contains numerous pores.

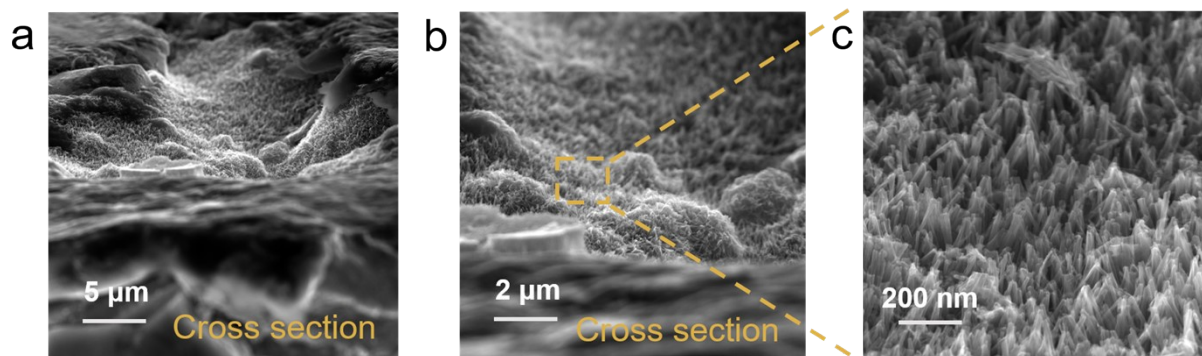


Figure S3. Cross-section SEM images of BTT evaporator. (a)(b) Low- magnification images showing the black TiO₂ nanotubes growing vertically upward from the FT substrate (bottom: cross-section, top: surface). (c) High-magnification view revealing the parallel arrangement of the nanotubes.

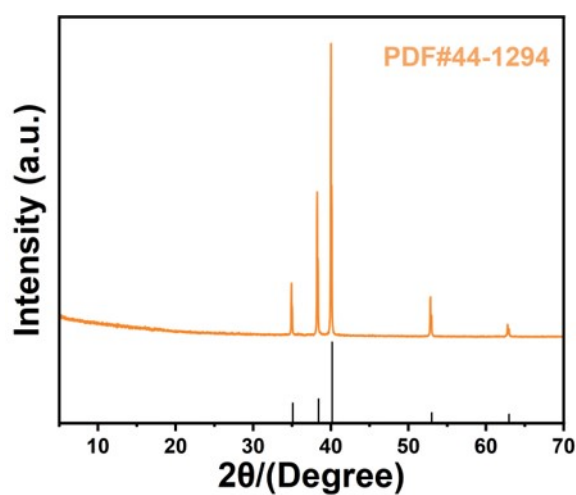


Figure S4. XRD image of the FT. The FT has high purity with no impurities present.

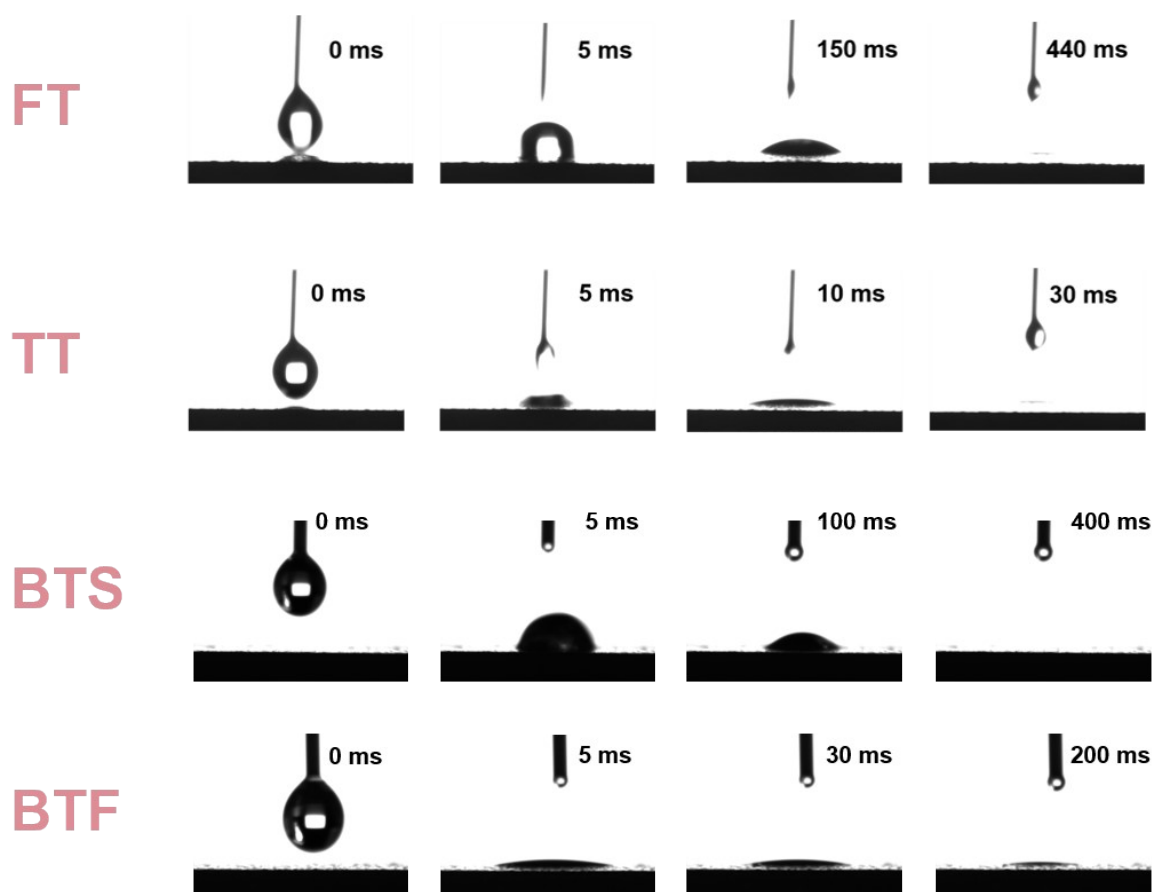


Figure S5. Water contact angle test for the FT, TT, BTS, BTF. For the FT, 5 mL water droplets can be completely absorbed within 440 ms. The TT, 5 mL water droplets can be completely absorbed within 30 ms. The BTS, 5 mL water droplets can be completely absorbed within 400 ms. The BTF, 5 mL water droplets can be completely absorbed within 200 ms.



Figure S6 The mass losses of BTT evaporator after ultrasonication. Due to the uneven voids of FT, the initial weights of the BTT evaporators are inconsistent. BTT evaporators were immersed in deionized water and subjected to ultrasonication for different durations (10, 30, and 60 min).

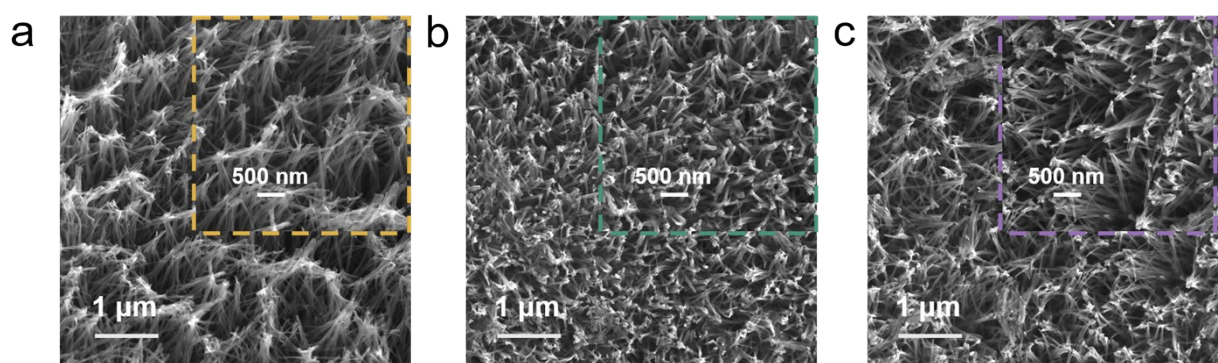


Figure S7. SEM images of evaporators after different ultrasonication times. a) 10min. b) 30min. c) 30min. Due to the uneven voids of FT, the initial weights of BTT evaporators are inconsistent. BTT evaporators were immersed in deionized water and subjected to ultrasonication for different durations (10, 30, and 60 min).

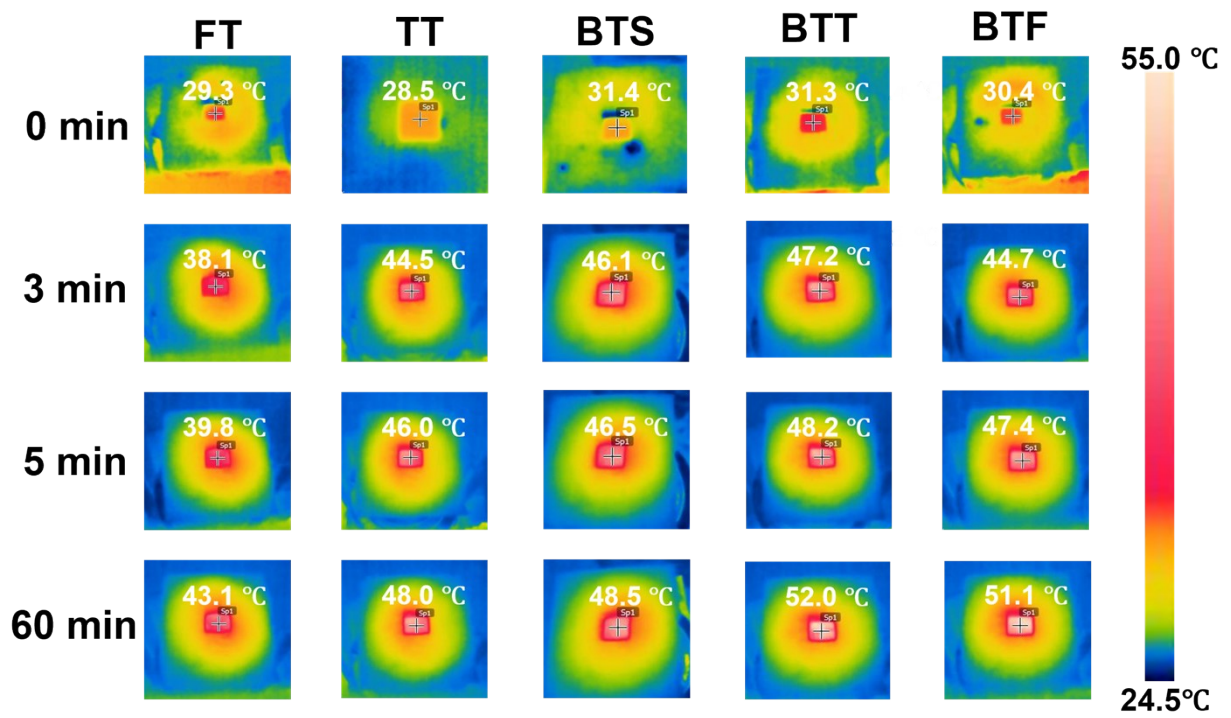


Figure S8. Infrared temperature images of the FT, TT, BTS, BTT, BTF. The infrared images were recorded from 0 s to 60min under 1 sun radiation.

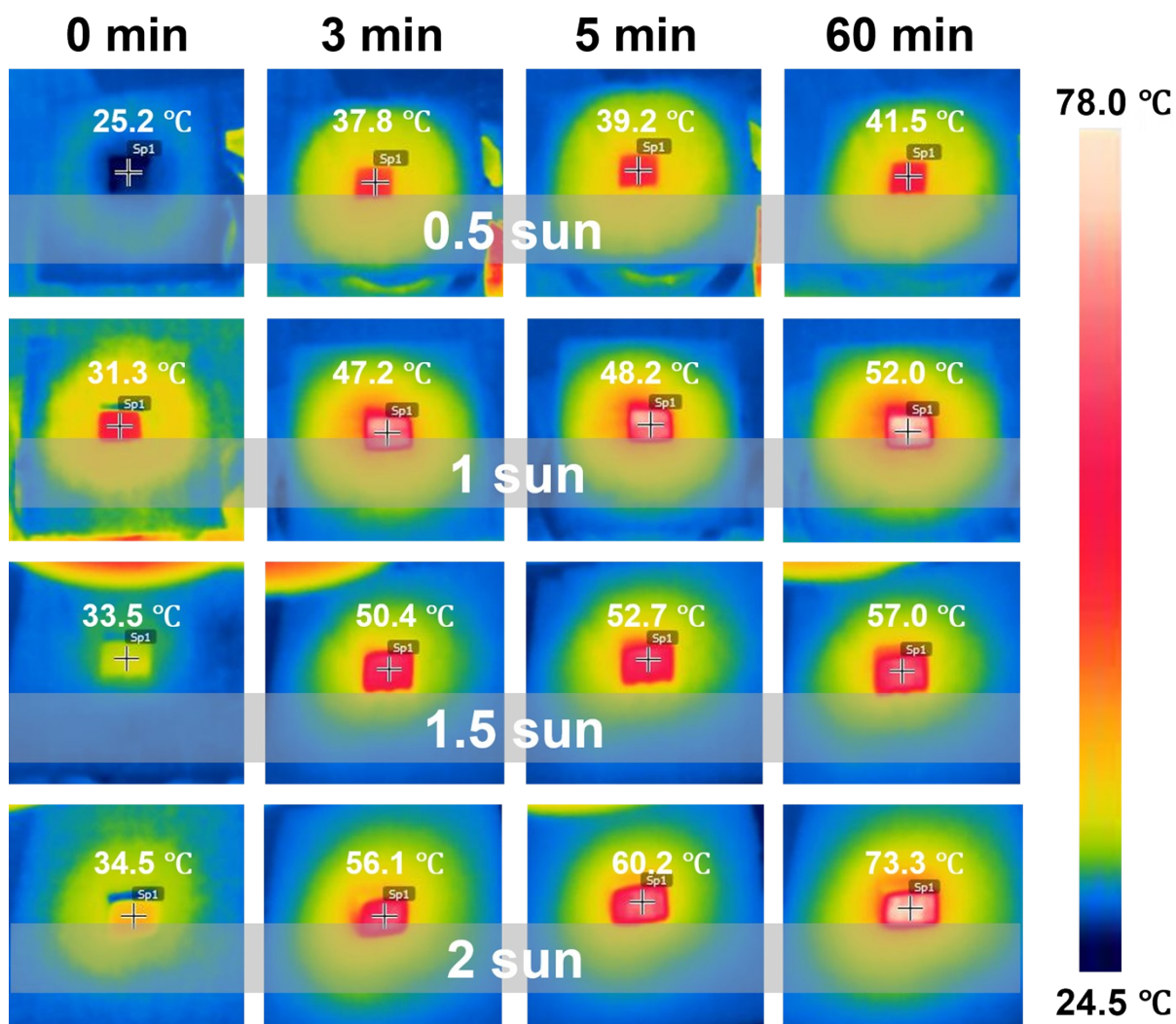


Figure S9. Infrared temperature images of BTT. The infrared images were recorded from 0 s to 60min under different radiation intensity (0.5 sun, 1 sun, 1.5 sun, and 2 sun).

Supplementary Table.

Table S1. Evaluation of water purity.

Sample Parameter	Deionized water	Domestic water	Simulated seawater	Purified Water
Conductivity ($\mu\text{S}/\text{cm}$)	3.01	245	43800	218
Total dissolved solids (ppm)	1.53	122.5	21900	110.5
Salinity (psu)	0.00	0.12	23.4	0.02
Resistivity ($\text{k}\Omega$)	321	4.08	2.28	447

Table S2. Evaporation rate comparison of FT, TT, BTS, BTT, BTF evaporators.

Sample Test	FT	TT	BTS	BTT	BTF
1	1.35	1.81	2.12	2.48	2.26
2	1.37	1.79	2.10	2.45	2.24
3	1.33	1.83	2.14	2.52	2.28
4	1.34	1.80	2.11	2.47	2.25
5	1.36	1.82	2.13	2.49	2.27
Mean \pm SD	1.35 \pm 0.02	1.81 \pm 0.02	2.12 \pm 0.02	2.48 \pm 0.03	2.26 \pm 0.02

Table S3. Evaporation rate of BTT evaporator under different solar radiation intensity.

Solar intensity Test	0.5 sun	1 sun	1.5 sun	2 sun
1	1.72	2.48	3.56	4.09
2	1.75	2.45	3.59	4.12
3	1.68	2.52	3.52	4.06
4	1.70	2.47	3.54	4.07
5	1.74	2.49	3.58	4.11
Mean ± SD	1.72 ± 0.05	2.48 ± 0.03	3.56 ± 0.04	4.09 ± 0.03

Table S4. Evaporation rate comparison of BTT evaporator in pure water and brines of different salt concentrations.

Concentrations Test	Pure water	3.5 wt%	7 wt%	10 wt%	15 wt%	20 wt%
1	2.56	2.48	2.25	2.13	1.94	1.80
2	2.57	2.45	2.26	2.14	1.95	1.81
3	2.55	2.52	2.24	2.12	1.93	1.79
4	2.58	2.47	2.27	2.15	1.96	1.82
5	2.54	2.49	2.23	2.11	1.92	1.78
Mean ± SD	2.56 ± 0.02	2.48 ± 0.03	2.25 ± 0.02	2.13 ± 0.02	1.94 ± 0.03	1.80 ± 0.02