Electronic Supplementary Material (ESI) for New Journal of Chemistry.
This journal is © The Royal Society of Chemistry and the Centre National de la Recherche Scientifique 2022

Supporting Information

Interface engineering of amorphous boron for high-efficiency interfacial solar steam generation

Bo Yang[a,*], Ying Feng[a], Wenjing Wang[a], Min Zhang[a], Xiangkai Kong[a], Qiangchun Liu[a], Haifeng Xu[b], Jixin Yao[c], Guang Li[d], Sheng-Qi Guo[e,*]

[a] *Anhui Province Key Laboratory of Pollutant Sensitive Materials and Environmental Remediation, School of Physics and Electronic Information, Huaibei Normal University, Huaibei 235000, China*

[b] *School of Information Engineering, Suzhou University; Suzhou 234000, China*

[c] *Anhui Province Key Laboratory of simulation and design for Electronic information system, Universities Joint Key Laboratory of photoelectric detection Science and Technology in Anhui Province, Hefei Normal University, Hefei, 230601, China*

[d] *School of Materials Science and Engineering, Anhui Key Laboratory of Information Materials and Devices, Key Laboratory of Structure and Functional Regulation of Hybrid Materials of Ministry of Education, Institute of Physical Science and Information Technology, Anhui University, Hefei 230601, China*

[e] *Tianjin Key Laboratory of Clean Energy and Pollutant Control, School of Energy and Environmental Engineering, Hebei University of Technology, Tianjin 300401, China*

Material and characterization

Materials

Commercially available amorphous boron powders (D50) were purchased from Aladdin. Polyvinyl alcohol (1750 ± 50) and Rhodamine B were purchased from Sinopharm Chemical Reagent Co. Commercially available cotton pads and polyurethane sponge were purchased from online supermarket. All raw materials were used without further purification.

Characterization

X-ray powder diffraction (XRD) was collected on a Philips X'Pert Pro Super diffractometer with graphite-monochromatized Cu-Kα radiation (λ= 1.54178 Å). The SEM images were implemented by SEM (FESEM, SU8220) to observe the morphology and microstructure of the samples. Ultraviolet-Visible-Near Infrared (UV-Vis-NIR) spectrum was recorded on a Perkin Elmer Lambda 950 UV-Vis-NIR spectrophotometer. Photos and demo videos were captured by using a digital camera.

Fabrication of photo-thermal conversion films and solar steam generation device

A solar steam generation device was combined by two-layer film. The top layer is the photo-thermal conversion film and the bottom layer is the heat insulation floating layer. The photo-thermal conversion film was prepared via the following steps. First, 2.0 g of boron powders and 0.01 g polyvinyl alcohol were added to 10 mL deionized water and magnetically stirred for 10 min. The ultrasonic treatment was applied to the sample for 20 min after magnetic stirring to attain a good dispersion. Finally, the dispersion was atomized and uniformly deposited on a cotton pads substrate by spray coating with an ultrasonic atomizing spray. The heat insulation floating layer was tailored using polyurethane sponge with 3 cm in radius and 3mm thick. The solar steam generation device was laminated by the above two films.

Water transport property experiment

Water transport property was verified by water absorption experiment and immersion test. For water absorption experiment, the cotton pad was hanged and fixed on the balance. And add water to the beaker set aside until the water surface is in contact with the cotton sheet. The weight change of the cotton pieces was recorded with a balance. For immersion test, prepare a certain concentration of rhodamine solution and the cotton pad was placed in the diluted ink to observe the degree of ink surface impregnation

Solar steam generation experiment

The light source for the steam generation experiments was provided by a solar simulator (CEL-HXF300-T3, Beijing China Education AuLight Technology Co., Ltd.) with an optical filter for the standard AM 1.5 G illumination, which was calibrated beforehand by an optical power meter. The mass change was accurately recorded by an electronic balance (JDJS-A5-1500G, Juding Tianheng (Suzhou) Weighing Equipment Co., Ltd.) coupled with a computer software for the calculation of the water evaporation rate. The real-time temperature and infrared image were captured by an infrared camera (PTi120, Fluke). The solar-vapour device floated on the surface of water in a 250 mL beaker (the inner radius is 3 cm) placed vertically under the light outlet of the xenon lamp.

Figure S1. The mass change of pure water and pristine cotton pads under 1 sun radiation.

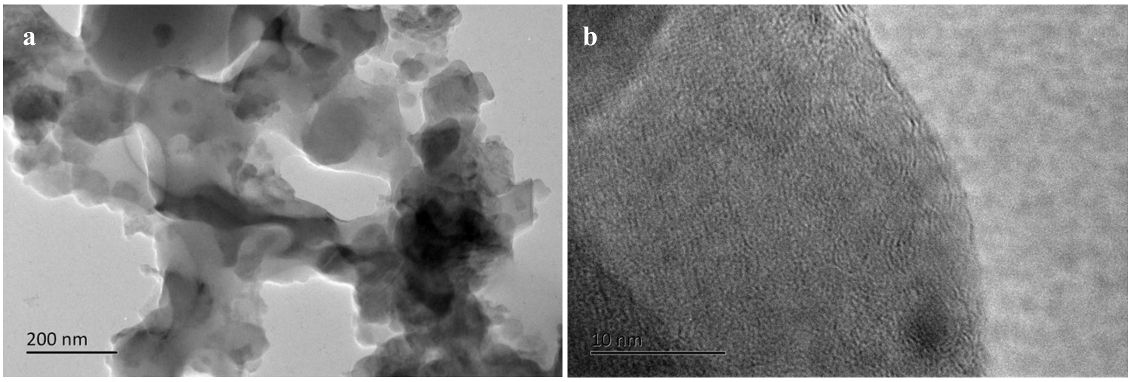

Figure S1. (a) TEM and (b) HRTEM images of the amorphous boron material.

Figure S2. The mass change of pure water and pristine cotton pads under 1 sun radiation.

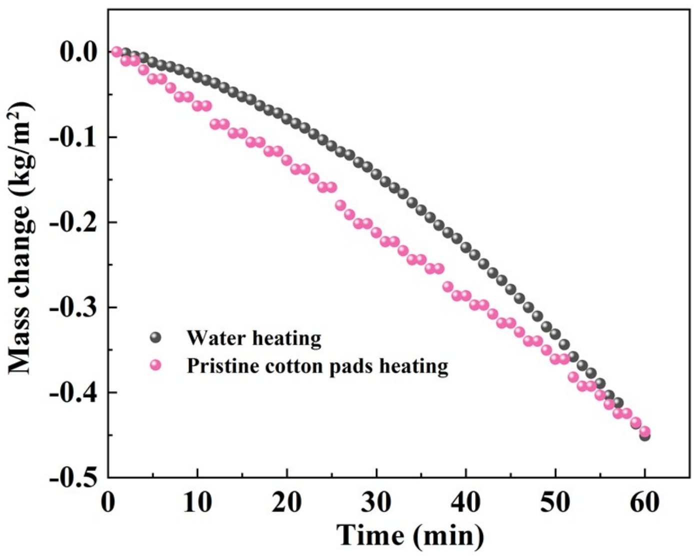

Figure S2. The mass change of pure water and pristine cotton pads under 1 sun radiation

Figure S3. Digital images of the strong performance of the device.

(a) (b)

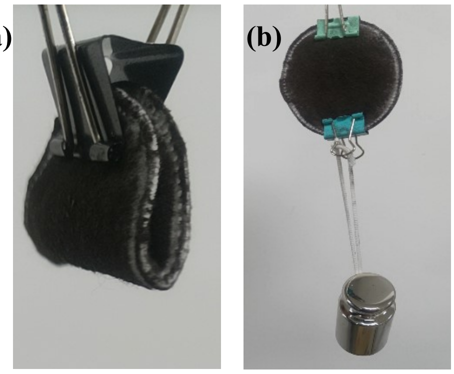

Figure S3. Digital images of the strong performance of the device.

Table S1. Detailed data for solar steam generation experiment.

	Water	**Bulk mode**	**Interfacial mode**
m_{light} $(kg/m^2{\cdot}h)$	0.45095	1.03525	2.43454
m_{dark} $(kg/m^2{\cdot}h)$	0.08139	0.11323	0.12385
m $(kg/m^2{\cdot}h)$	0.36956	0.92202	2.31069
E_{equ} (kj/kg)	2260	1624.494	1485.195
η (%)	23.2	41.6	95.3

Table S2. A list of evaporation rate and efficiency compared to other studies.

Evaporater	E_{Evap} ($kg \cdot m^{-2}\ h^{-1}$)	η (%)	Light Intensity ($kW \cdot m^{-2}$)	Ref.
RGO-SA-cellulose aerogel	2.25	88.9	1	1
Perovskite $La_{0.5}Sr_{0.5}CoO_3$	2.45	93.0	1	2
Carbon black-based nanofiber	1.48	98.6	1	3
Porous Photothermal Hydrogel	1.833	83.29	1	4
Black Gold Film	1.51	94.5	1	5
Polyelectrolyte hydrogel	1.69	95.94	1	6
Superhydrophilic aerogel	1.46	91.5	1	7
Porous aero-cryogels	2.16	93.6	1	8
Carbonized banana foam	1.51	93.3	1	9
Nanoporous black silver	1.42	92.6	1	10
Amorphous boron	*2.43*	*95.3*	*1*	*This work*

References

1. Storer, D. P.; Phelps, J. L.; Wu, X.; Owens, G.; Khan, N. I.; Xu, H. L., Graphene and Rice-Straw-Fiber-Based 3D Photothermal Aerogels for Highly Efficient Solar Evaporation. *Acs Applied Materials & Interfaces* **2020,** *12* (13), 15279-15287.

2. Fan, D. Q.; Min, H. H.; Zhang, H.; Tang, Y. C.; Yang, X. F.; Lu, Y., Architecting a bifunctional solar evaporator of perovskite $La_{0.5}Sr_{0.5}CoO_3$ for solar evaporation and degradation. *Journal of Materials Science* **2021,** *56* (33), 18625-18635.

3. Zhang, R.; Zhou, Y. W.; Xiang, B.; Zeng, X. J.; Luo, Y. L.; Meng, X. K.; Tang, S. C., Scalable Carbon Black Enhanced Nanofiber Network Films for High-Efficiency Solar Steam Generation. *Advanced Materials Interfaces* **2021,** *8* (24), 2101160.

4. Ni, A.; Fu, D.; Lin, P.; Xia, Y.; Pei, D.; Han, X.; Hua, S.; Li, S.; Zhang, T., Rapid Fabrication of Porous Photothermal Hydrogel Coating for Efficient Solar-Driven Water Purification. *ACS Appl Mater Interfaces* **2022,** *14* (39), 44809-44820.

5. Zhang, Y.; Wang, Y.; Yu, B.; Yin, K.; Zhang, Z., Hierarchically Structured Black Gold Film with Ultrahigh Porosity for Solar Steam Generation. *Advanced Materials* **2022,** *n/a* (n/a), 2200108.

6. Peng, B.; Lyu, Q.; Gao, Y.; Li, M.; Xie, G.; Xie, Z.; Zhang, H.; Ren, J.; Zhu, J.; Zhang, L.; Wang, P., Composite Polyelectrolyte Photothermal Hydrogel with Anti-biofouling and Antibacterial Properties for the Real-World Application of Solar Steam Generation. *ACS Applied Materials & Interfaces* **2022,** 14(14): 16546-16557.

7. Yan, J. Y.; Zhang, Z.; Shi, Y. X.; Che, Q. L.; Miao, Q.; Meng, G. H.; Liu, Z. Y., An anti-oil-fouling superhydrophilic composite aerogel for solar saline alkali water desalination. *New Journal of Chemistry* **2022,** *46* (30), 14479-14489.

8. Li, S.; Yang, X.; He, Y.; Wang, Y.; Liao, D.; Chen, Y.; Xie, H.; Liu, H.; Zhou, L., Hierarchical porous aero-cryogels for wind energy enhanced solar vapor generation. *Cellulose* **2021,** *29* (2), 953-966.

9. Ma, S.; Wu, Y.; Lv, R.; Gao, X.; Wang, Q., Mechanically robust biomass-derived carbonaceous foam for efficient solar water evaporation. *New Journal of Chemistry* **2022**.

10. Yu, B.; Wang, Y.; Zhang, Y.; Zhang, Z. H., Nanoporous black silver film with high porosity for efficient solar steam generation. *Nano Research* **2022**, 1-9.