Paper Presentation

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Scalable, Green, and Cost-Effective Carbonized Sand for Efficient Solar Desalination

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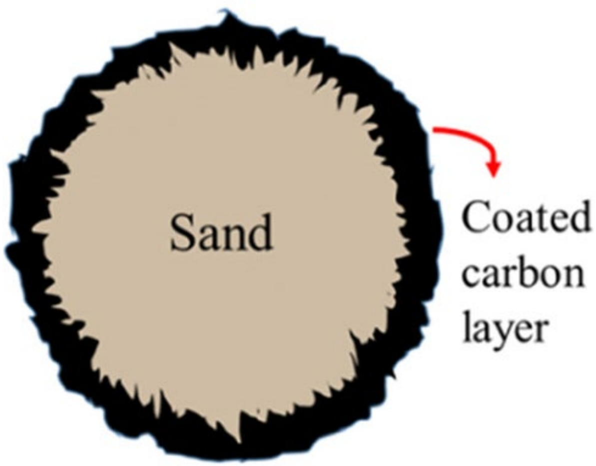

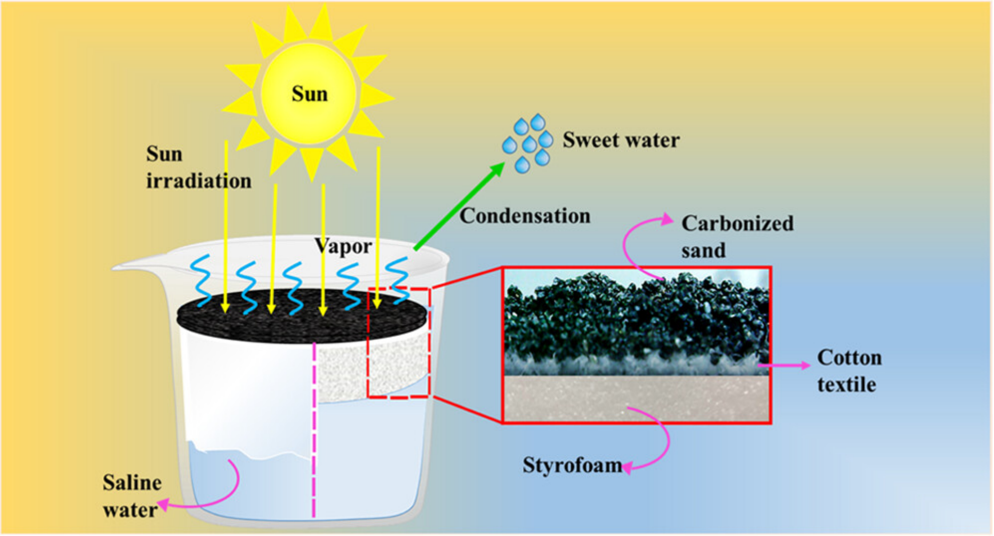

Background

CHEMISTRY OF MATERIALS
Communication
Cite This: *Chem. Mater.* 2018, 30, 6217−6221
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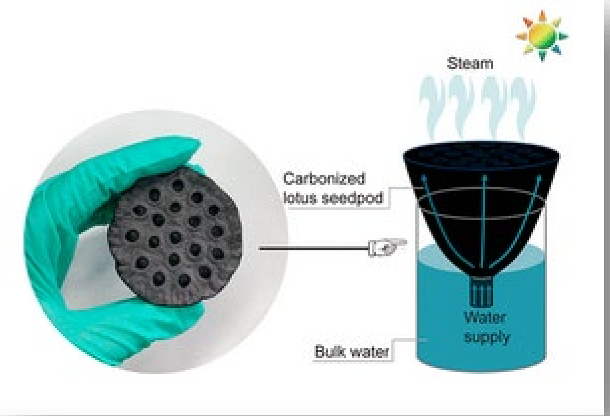
Hierarchical Porous Carbonized Lotus Seedpods for Highly Efficient Solar Steam Generation

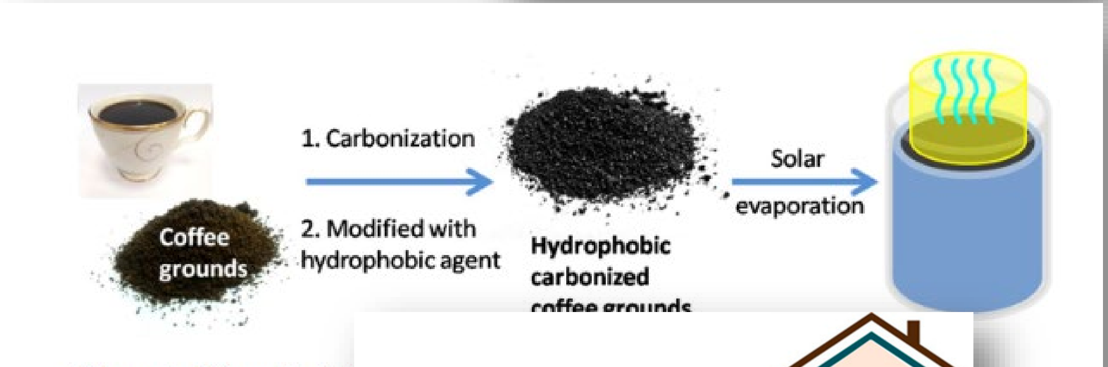
Jing Fang,[‡] Jie Liu,[‡] Jiajun Gu,* Qinglei Liu,* Wang Zhang, Huilan Su, and Di Zhang

State Key Laboratory of Metal Matrix Composites, School of Materials Science and Engineering, Shanghai Jiao Tong University, Shanghai 200240, China



Preparation of efficient photothermal materials from waste coffee grounds fo evaporation and water purific

Chih-Feng Wang[1,2], Chih-Lin Wu[3], Shiao-Wei Kuo[4], Wei-Song Hung[1], Kuo-Ju
Hsieh-Chih Tsai[1], Chi-Jung Chang[5] & Juin-Yih Lai[1,2]



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Phonon-Engineered Hard-Carbon Nanoflorets Achieving Efficient Solar-Thermal Based Water Evaporation and Spac

Ananya Sah, Sumit Sharma, Sandip Saha,* and Chandramouli Subramaniam*

Cite This: *ACS Appl. Mater. Interfaces* 2023, 15, 43810−43821
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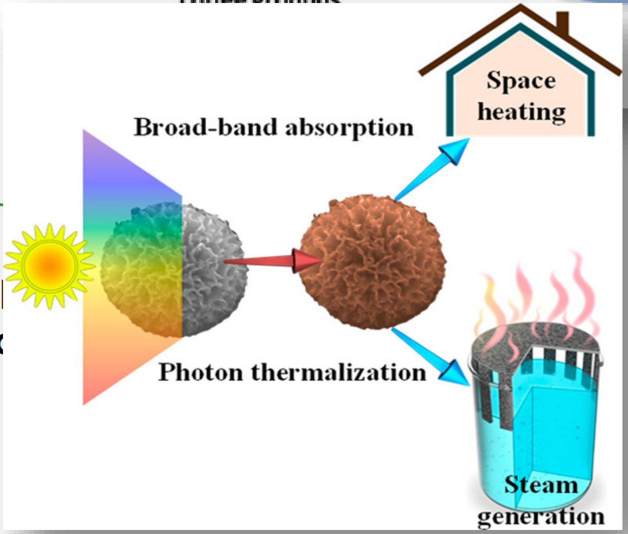

Background

nature COMMUNICATIONS

ARTICLE

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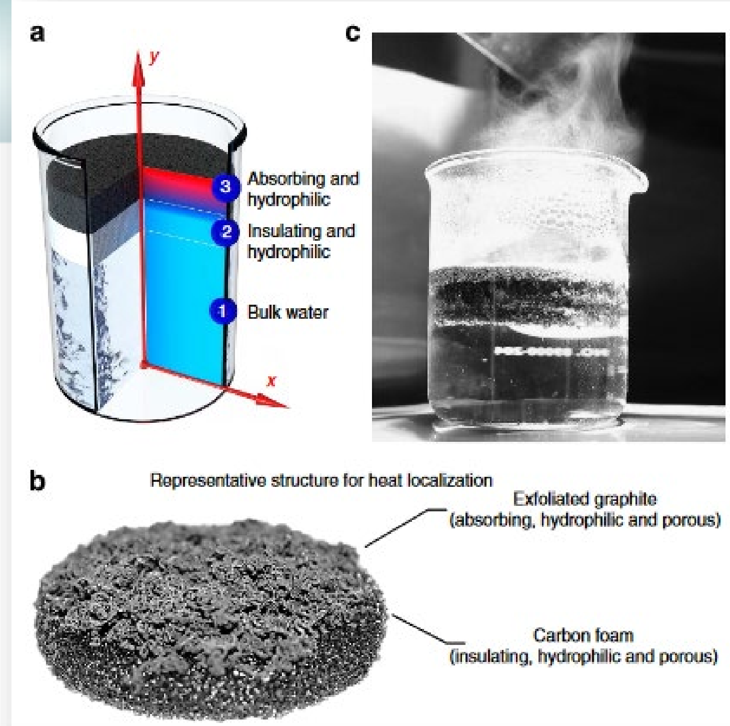
Solar steam generation by heat localization

Hadi Ghasemi[1], George Ni[1], Amy Marie Marconnet[1,2], James Loomis[1], Selcuk Yerci[1,3], Nenad Miljkovic[1] & Gang Chen[1]



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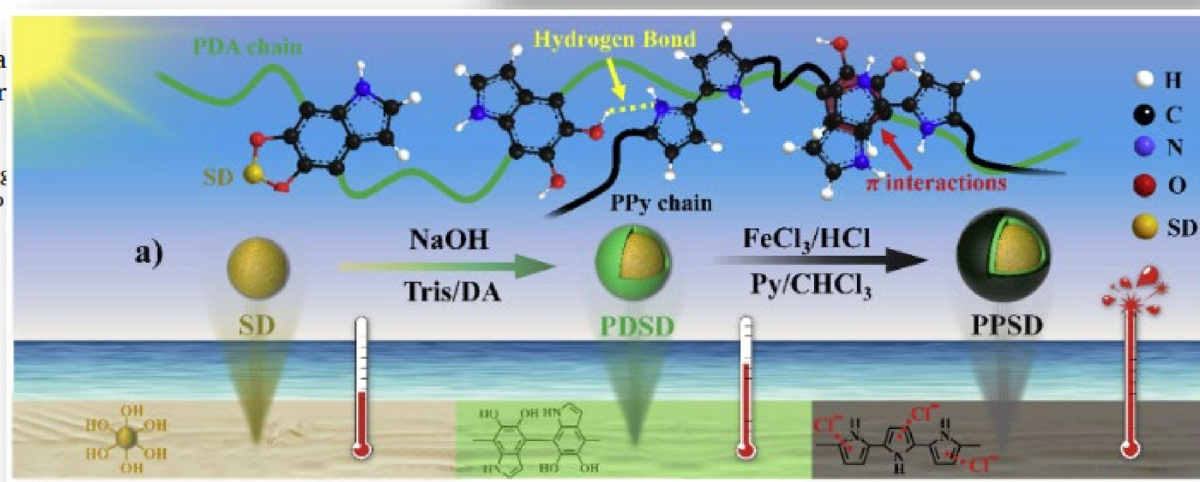
Full paper

Collective behaviors mediated multifunctional black sa
towards environmentally adaptive solar-to-thermal pur
water harvesting

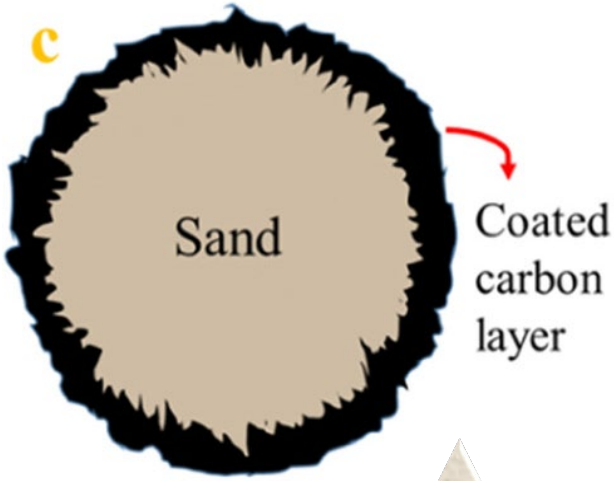
Feng Ni[a,b], Peng Xiao[a,b,*], Nianxiang Qiu[c], Chang Zhang[a], Yun Liang
Junyuan Xia[a,b], Zhixiang Zeng[a,b], Liping Wang[a,b], Qunji Xue[a,b], Tao

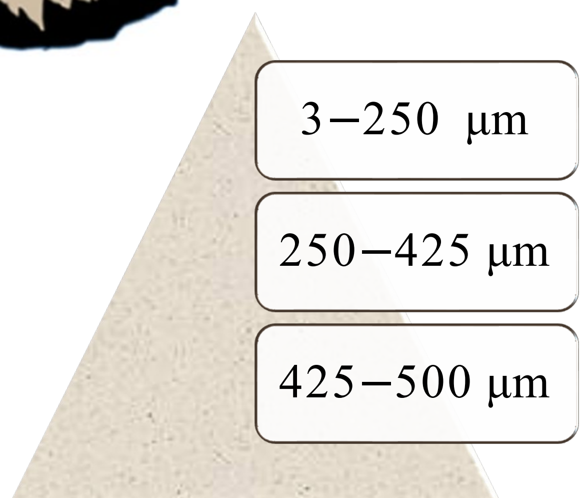


Why this paper?

Materials	Evaporation rate (kg/m^2h)	Efficiency	Cost
Carbonized lotus seedpods	1.30	86.5%	moderate
Black sand	1.43	81% (2D structure) 94.96% (3D structure)	high
Carbonized and modified corn-cob	1.68	99.32%	high
Modified cigarette filters	1.81	90.5%	high
Carbonized and modified coffee grounds	1.05	71.7 %	high
Reduced graphene oxide composite fiber	1.54	97.83%	moderate
Graphite coated basswood	1.2	80%	low
Carbonized sand	1.53	82% (2D structure) 94% (3D structure)	low

Introduction





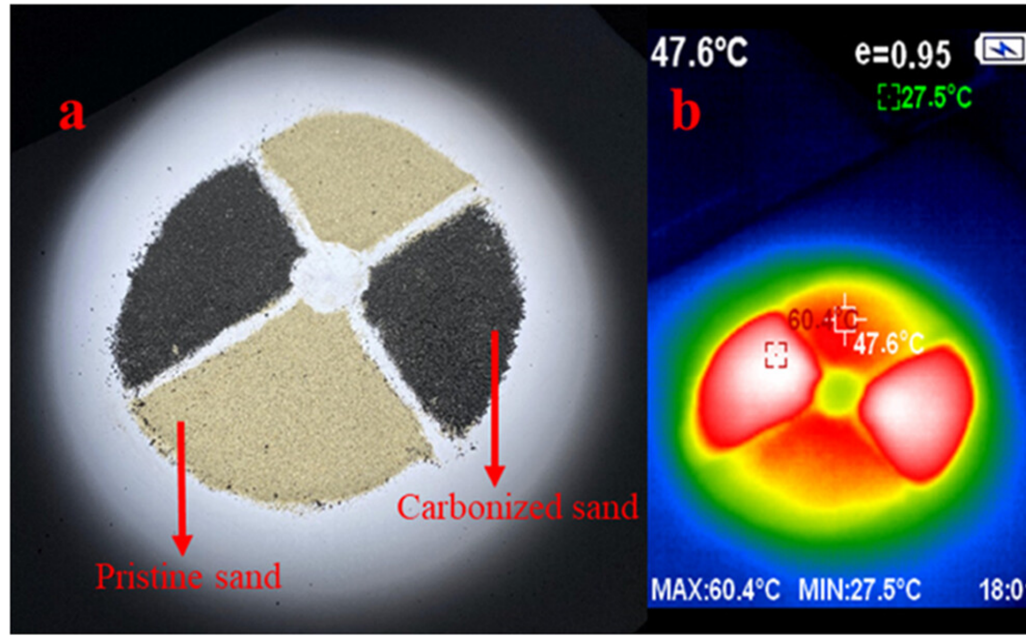
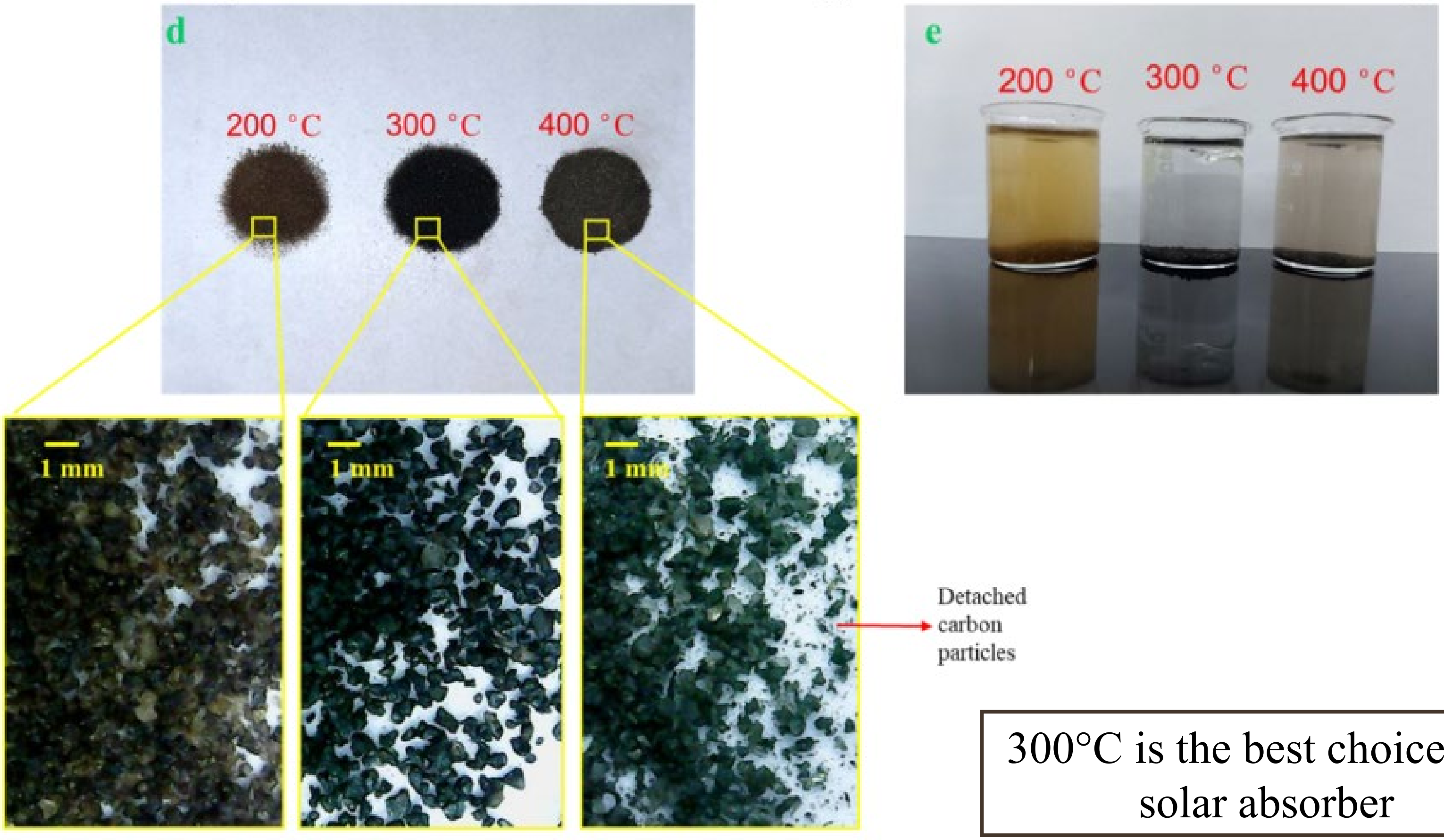


Fig: (a) Digital photo and (b) IR photo of carbonized and natural sand under 1 sun irradiation after 5 min.

1 Sun = 1000W/m²

Optimum temperature



300°C is the best choice as a solar absorber

Fig: (d) The colour of the carbonized sand with different carbonization temperatures, (e) different carbonized sands stability in water.

Experimental data

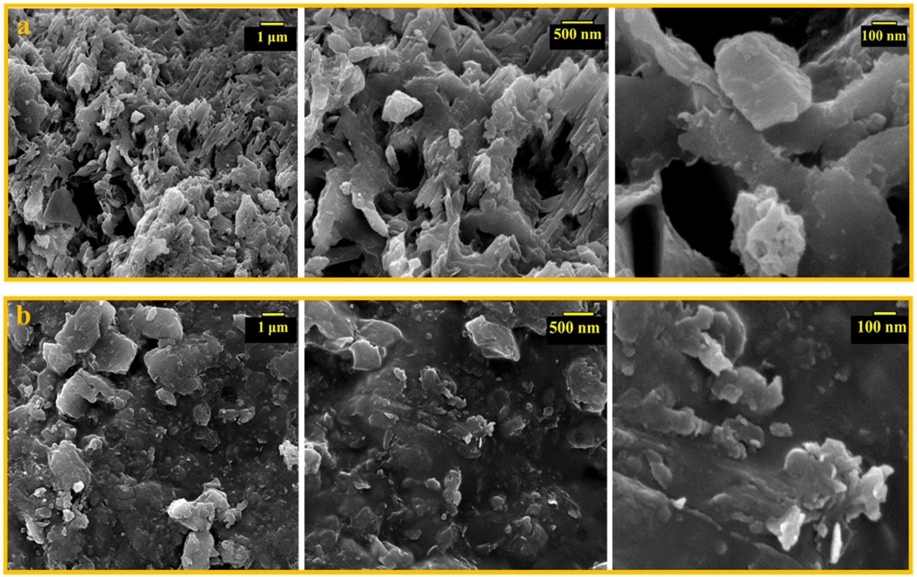


Fig: SEM images of (a) natural sand and (b) carbonized sand at three different magnifications.

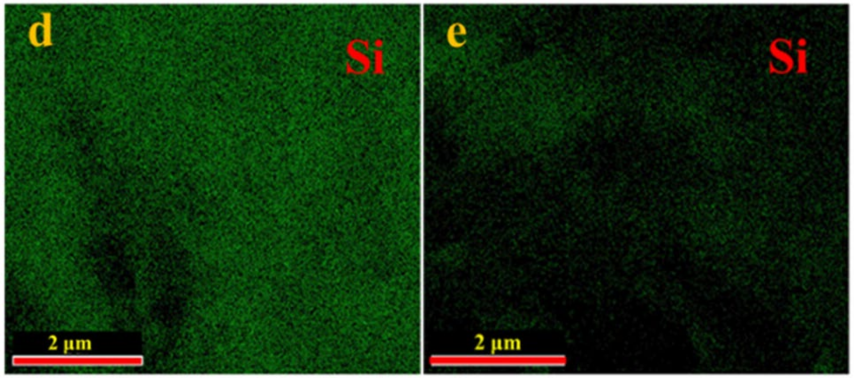


Fig: Si mapping of (d) natural sand and (e) carbonized sand for carbon.

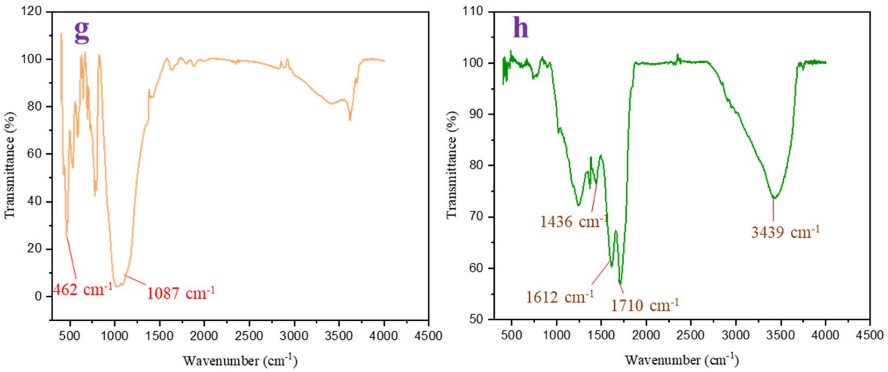


Fig: FT-IR spectra of (g) natural sand and (h) carbonized sand.

Superhydrophilicity

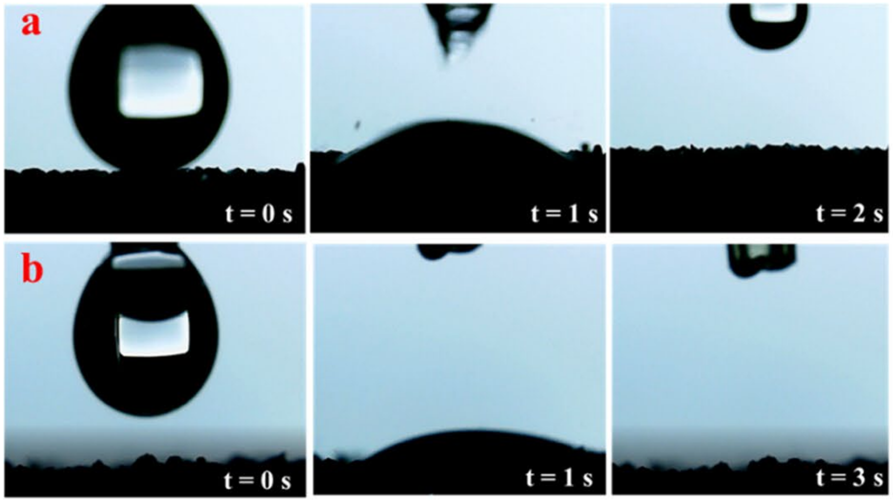
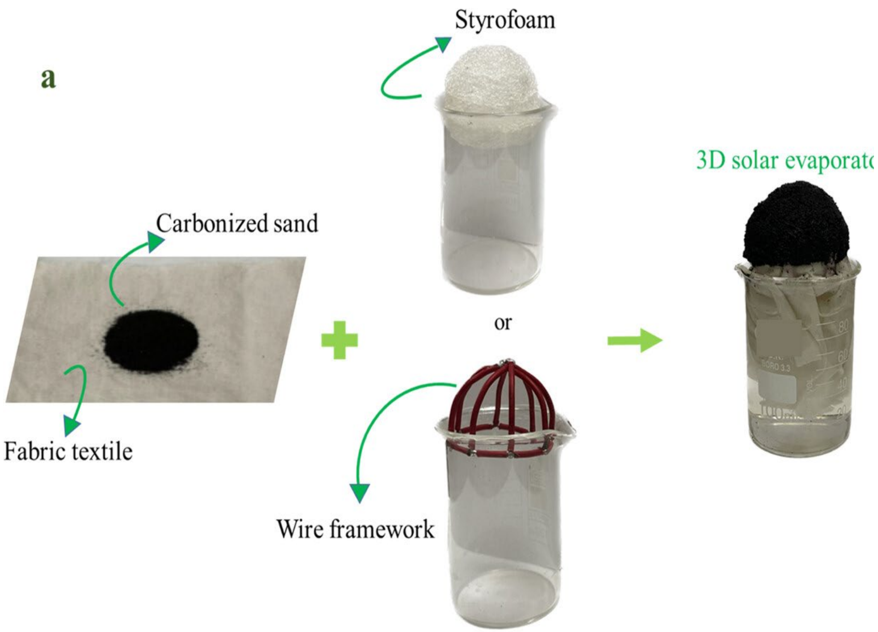
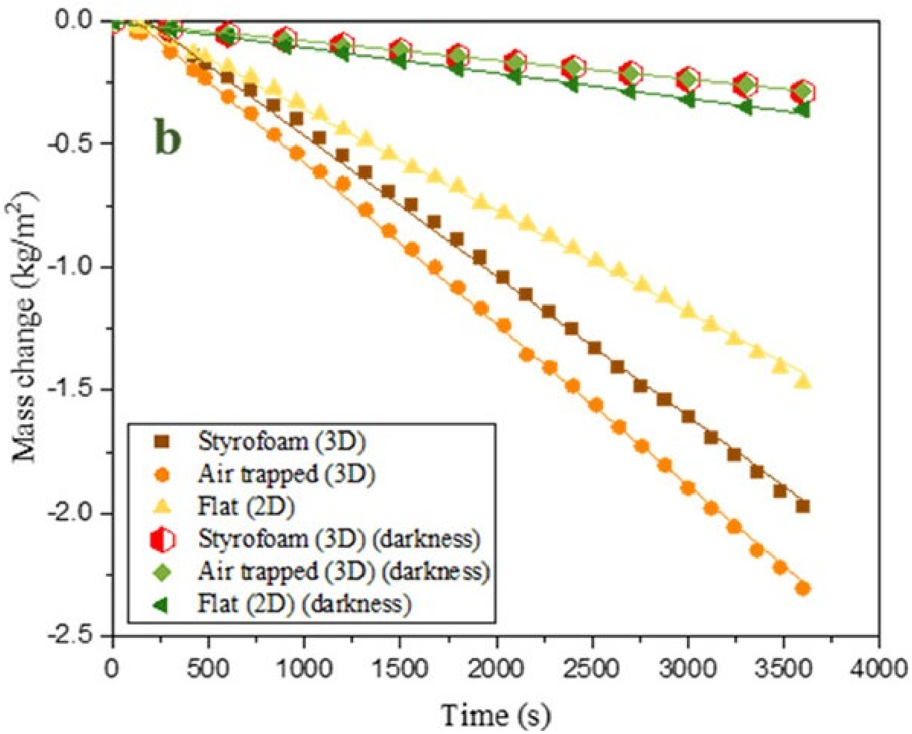


Fig: Contact angle of water on (a) natural sand and (b) carbonized sand.

The system set-up

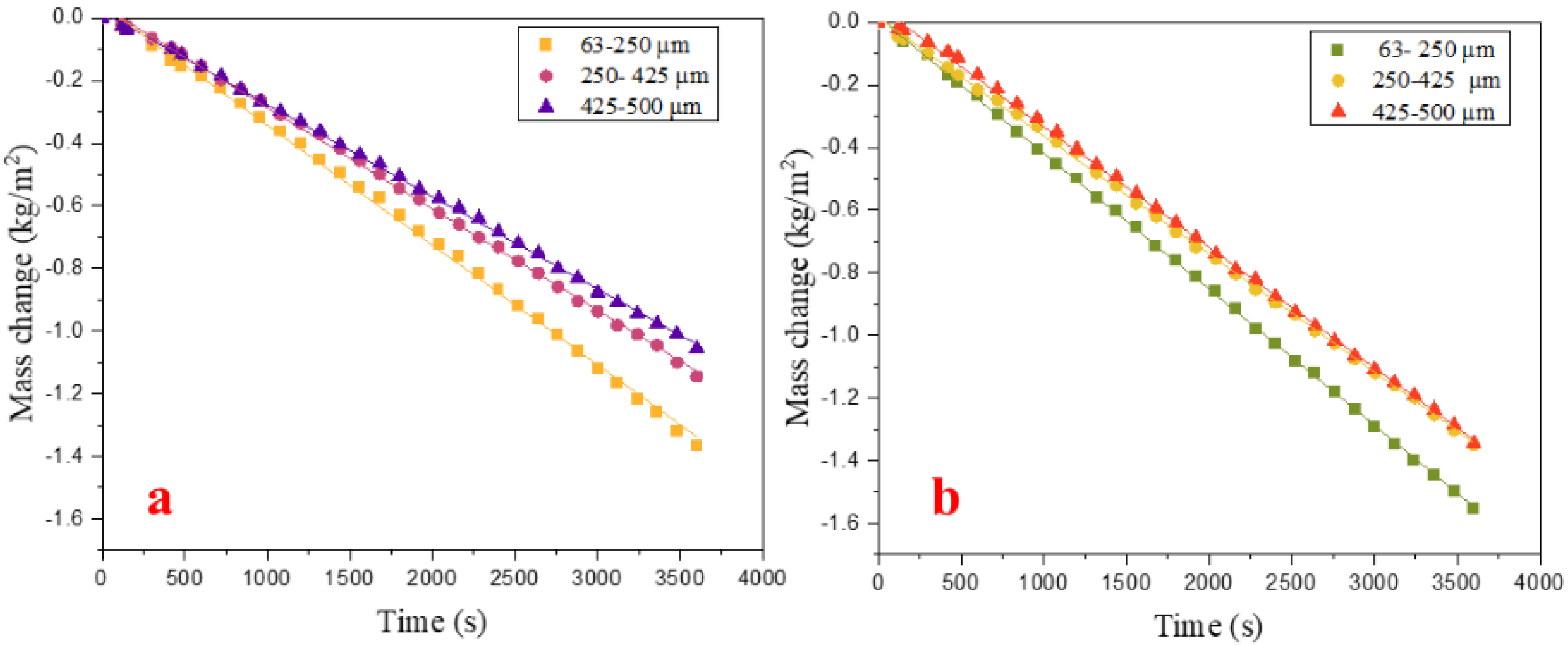




The 3D structure with air trapped under it has better performance (2.31 kg/m^2h) than the one with Styrofoam (1.97 kg/m^2h).

Fig: (a) Schematic and digital image of the solar evaporator 3D structure and (b) mass change of water by time with different 2D and 3D solar evaporator structures at 1 sun.

Optimum size



Sand particle with the size of 63−250 µm shows the best performance even when it is natural sand.

Fig: Mass change of water versus time under 1sun illumination using solar collector having for different sizes of (a) natural sand and (b) carbonized sand.

Effect of thickness and light intensity

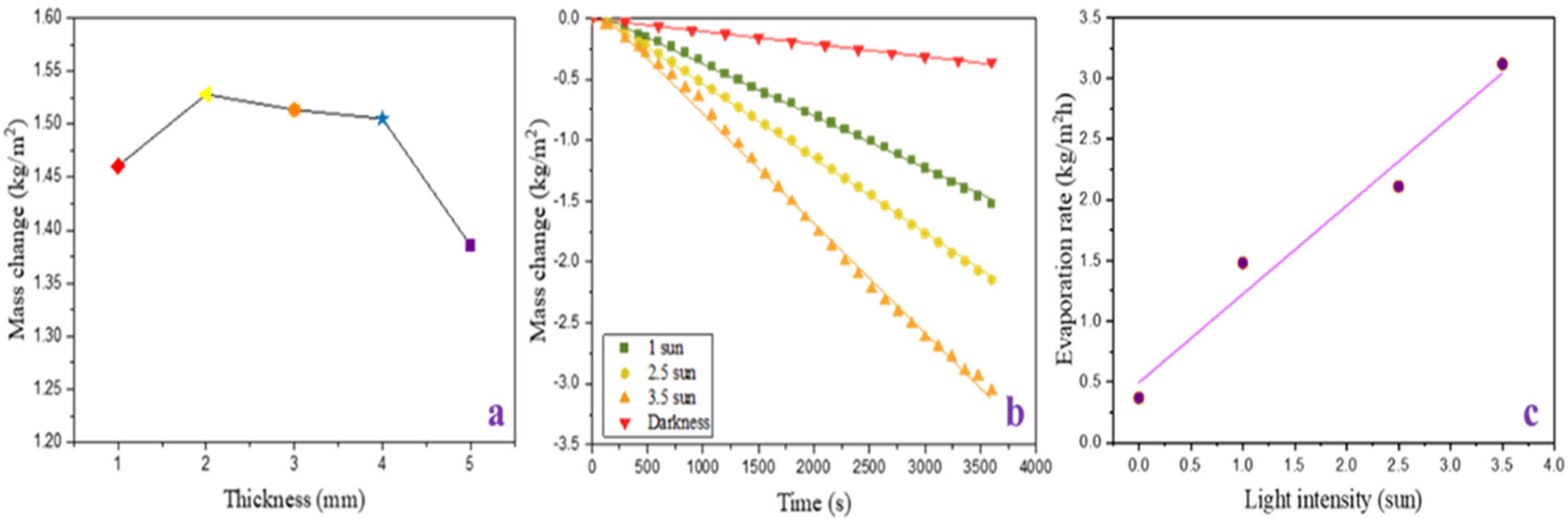


Fig: (a) Mass change of water with different thicknesses of the carbonized sand layer on the textile surface, illuminated at 1 sun for 1 h, (b) mass change of the water by time under 1, 2.5, and 3.5 sun irradiation, and (c) linear relation between the evaporation rate and light intensity for carbonized sand.

Surface temperature of 2D structure

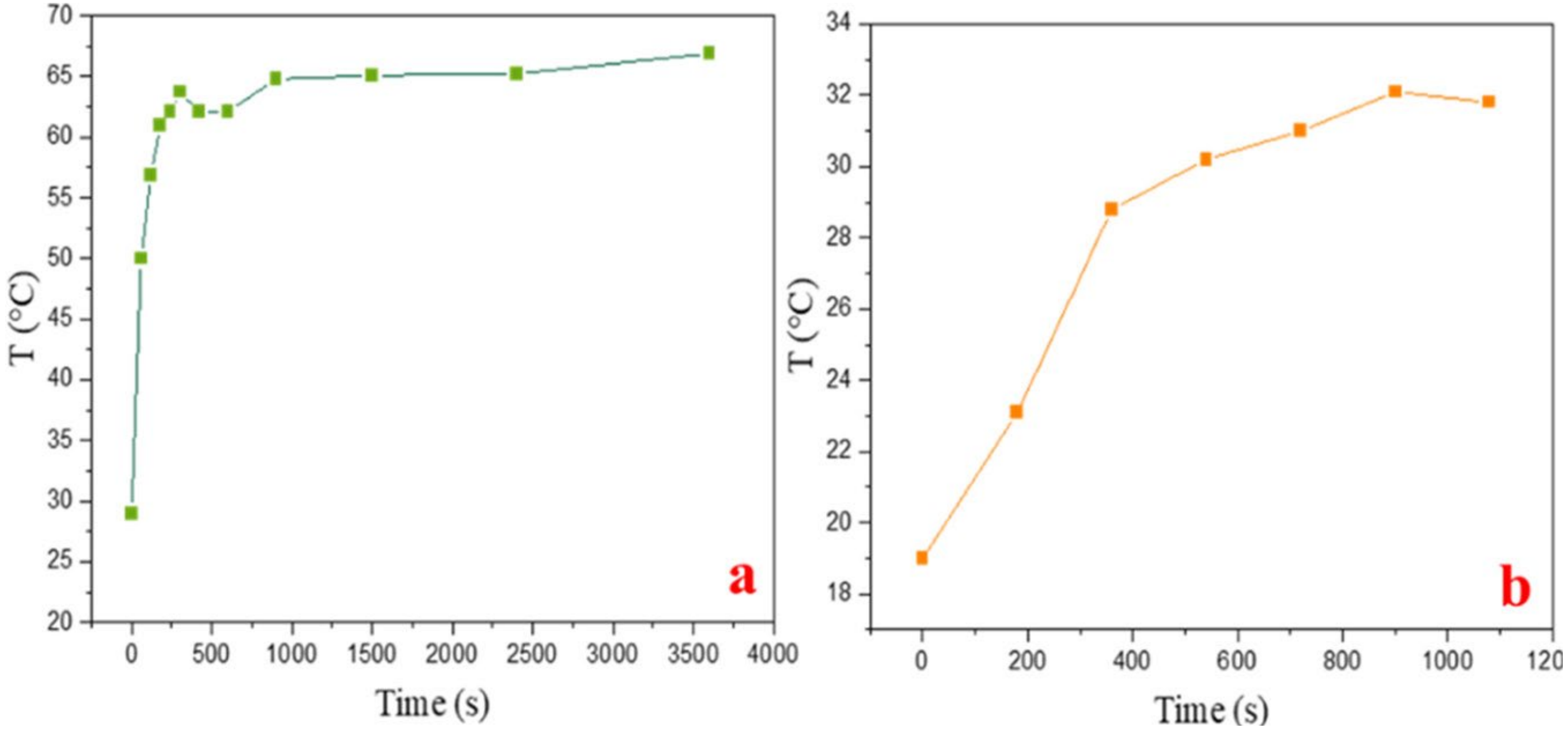


Fig: (a) Dry carbonized sand, (b) wet carbonized sand on the 2D structure under 1 sun irradiation

Surface temperature and stability of 2D

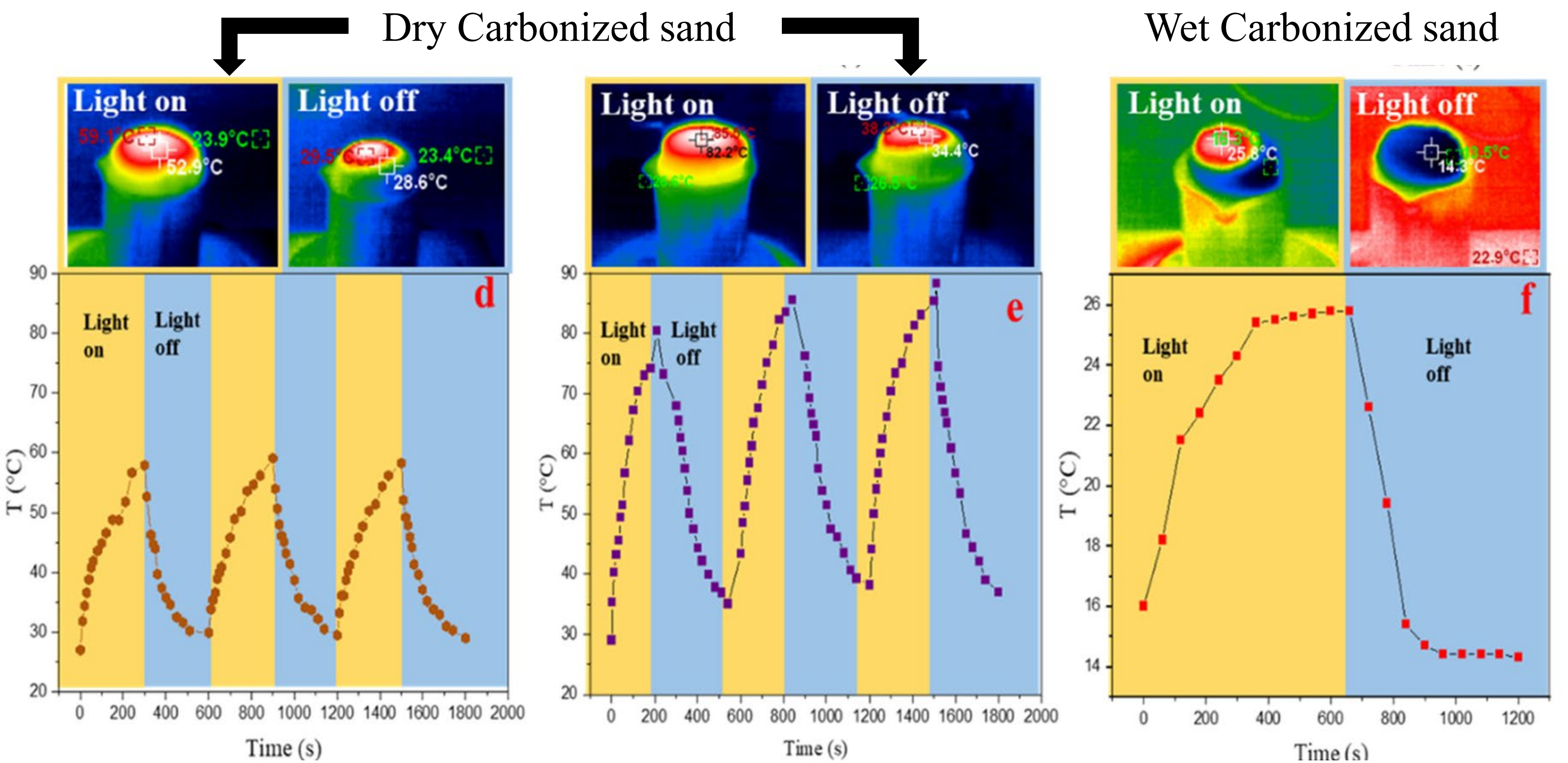
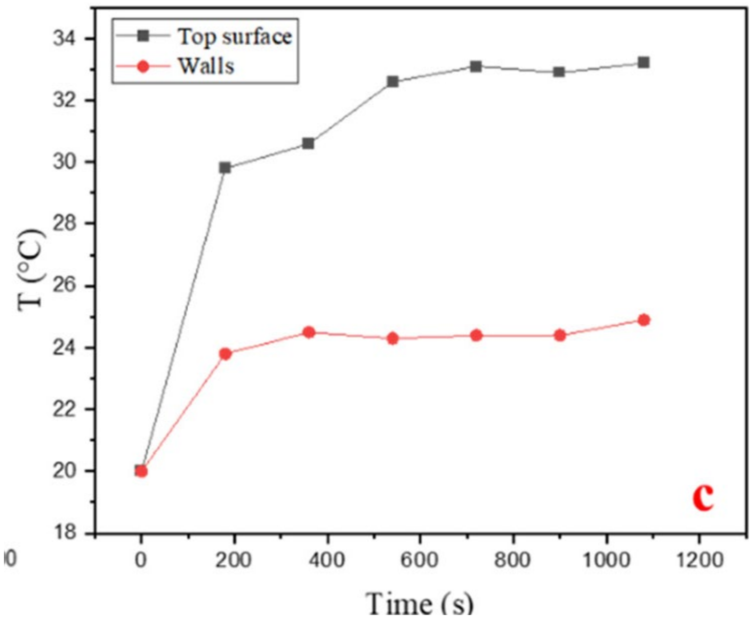
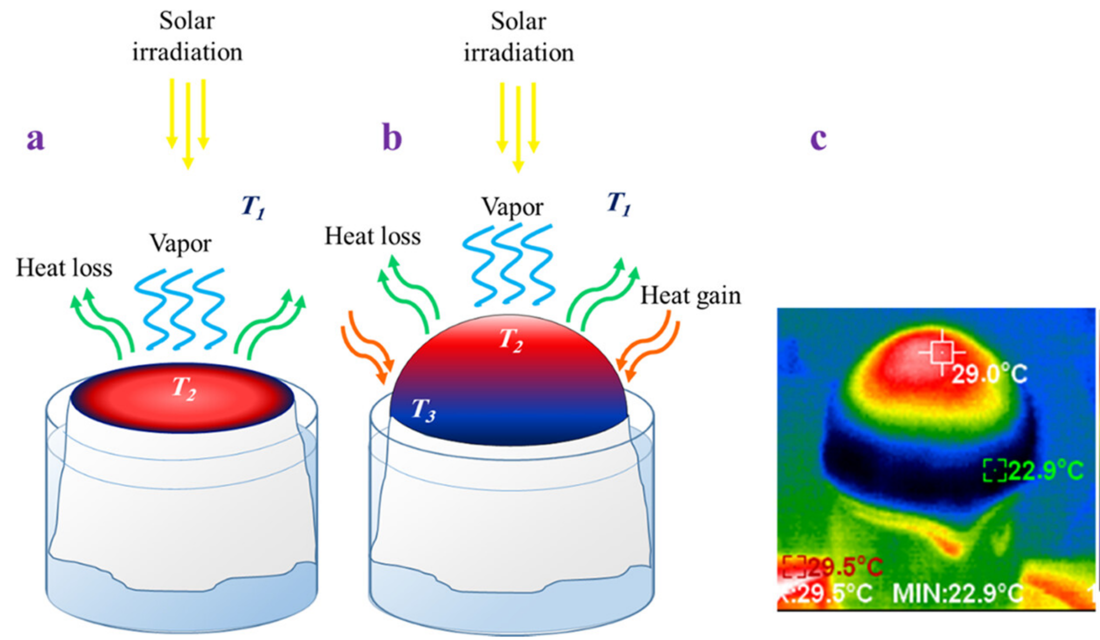


Fig: Surface temperature of the dry carbonized sand under (d) 1 sun and (e) 3 sun irradiation; (f) surface temperature of the wetted carbonized sand under 1 sun irradiation.

Surface temperature of 3D system





- The efficiency of the system should be 89.41%
- However, the calculated efficiency for the 2D system under 1 sun irradiation is 82%
- The calculated efficiency for 3D solar evaporator is 94%

External Factors:

1. Wind speed
2. Solar flux
3. Environment temperature

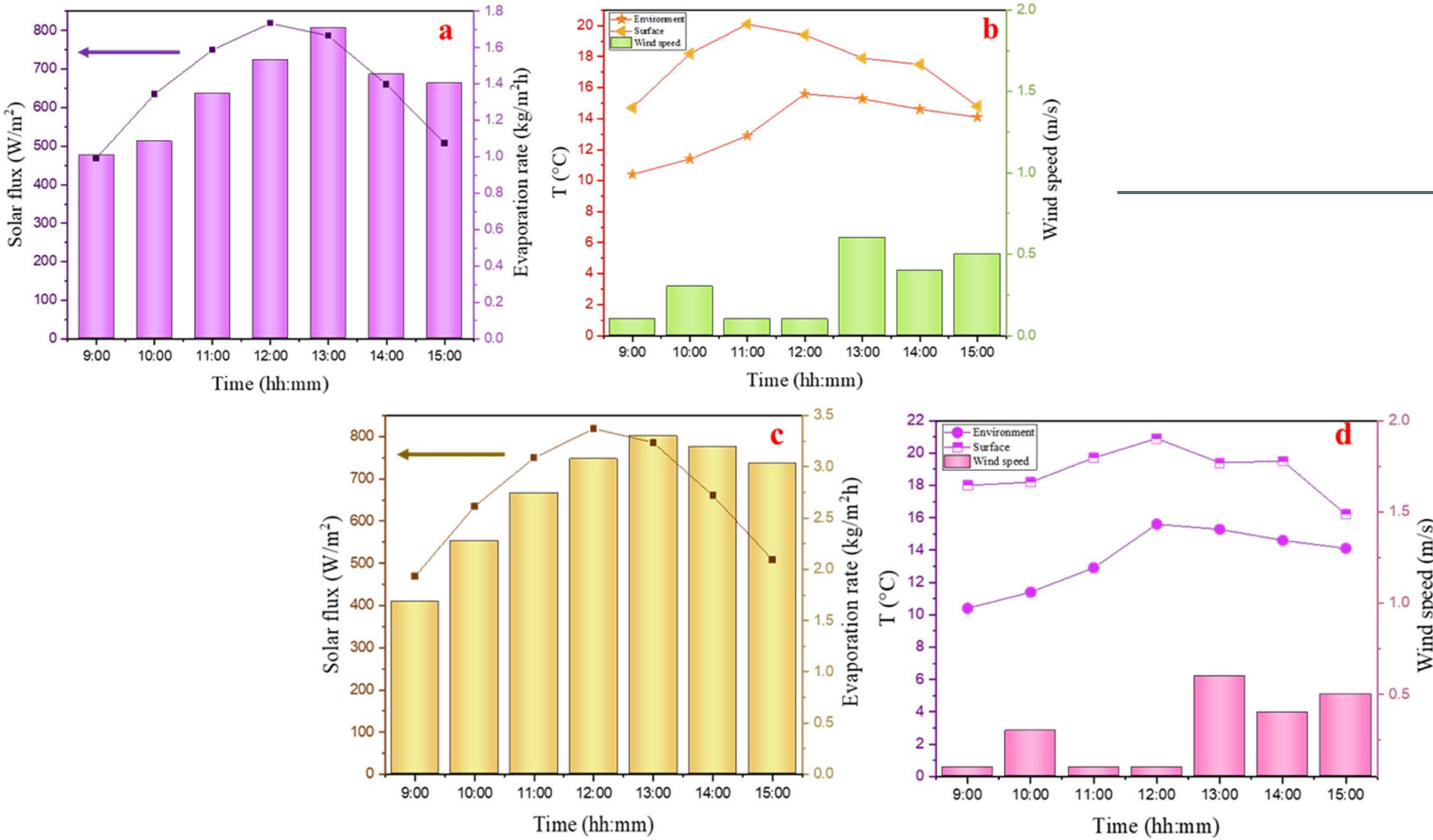
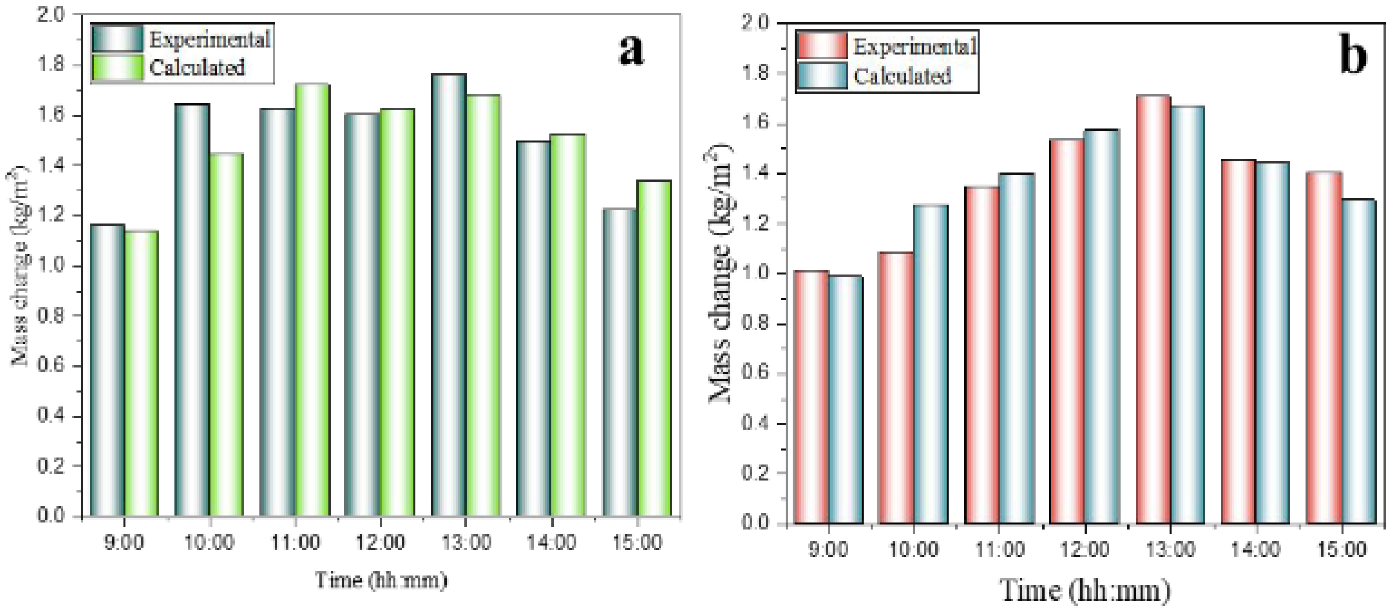


Fig: (a,c) Mass change of water and solar flux and (b,d) wind speed, surface temperature, and environment temperature during different times of the day for the 2D and 3D structure on 22February 2023.

For understanding the effect of each parameter on the evaporation rate, the wind speed, solar flux, and environment temperature (data of 22 and 27 February 2023) were normalized ($X = (x - x_{min})/(x_{max} - x_{min})$) for the 2D system and were fitted to the following simple equation using Nonlinear Least-Squares Regression (Curve Fitter)

$$Y = 0.84662 + 0.441036\,X_1 + 0.428916\,X_2 + 0.292715\,X_3 \qquad (7)$$



(a) 22, February, 2023, (b) 27, February, 2023.

Laboratory set-up

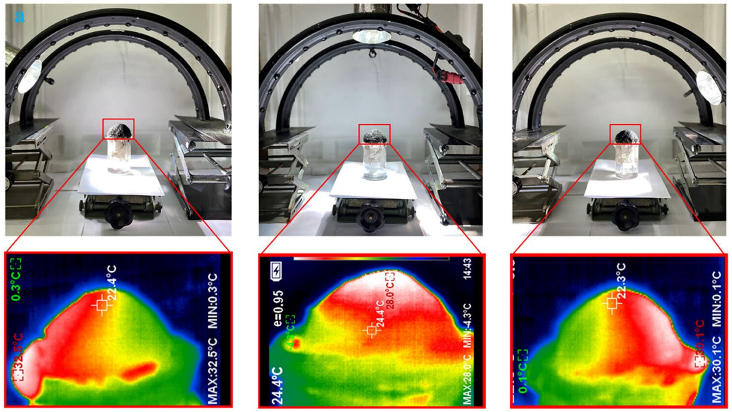


Fig: Surface temperature of the 3D structure during the day (a) under simulator light in the laboratory.

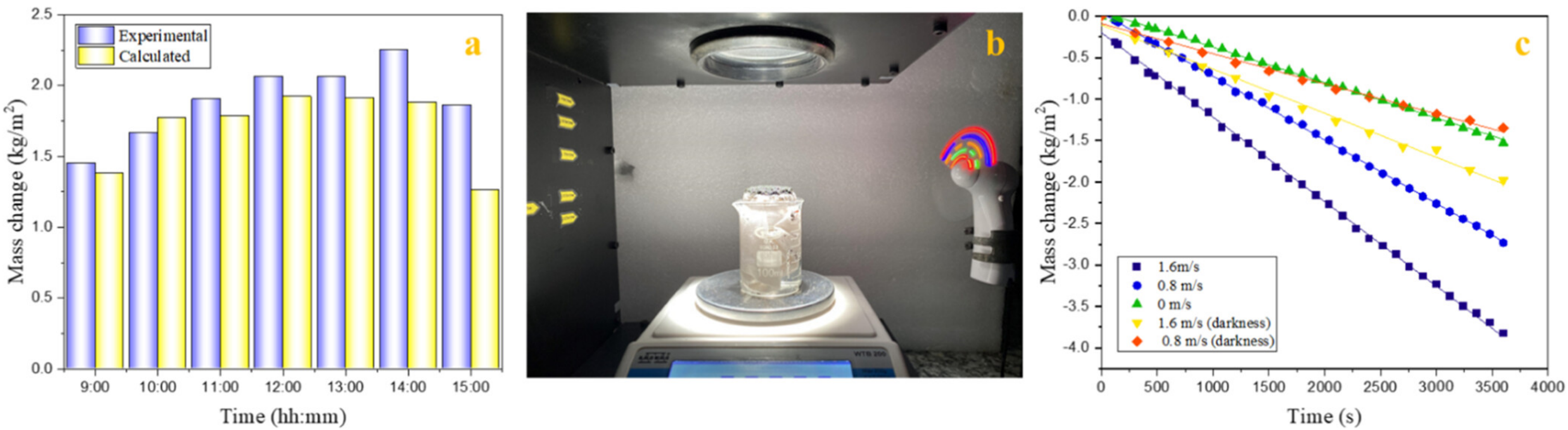


Fig: (a) Experimental and the predicted data of mass change using eq 7 for 19 October 2022, (b) digital image of the evaporation system with wind, and (c) mass change for water with time at different wind speeds.

Potential of carbonized sand

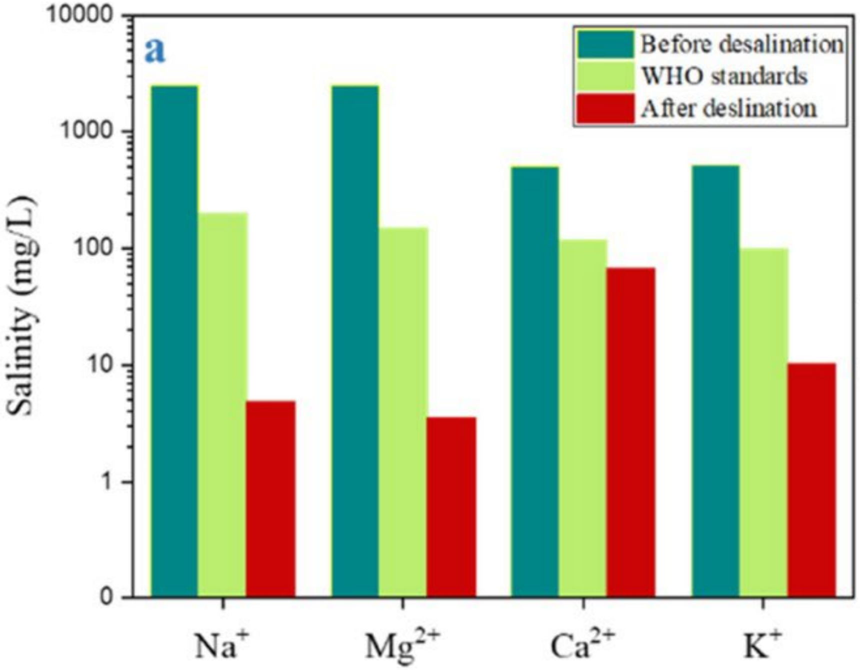


Fig: (a) ICP-OES results of saline water and treated water.

Treatment of acidic and alkaline solution

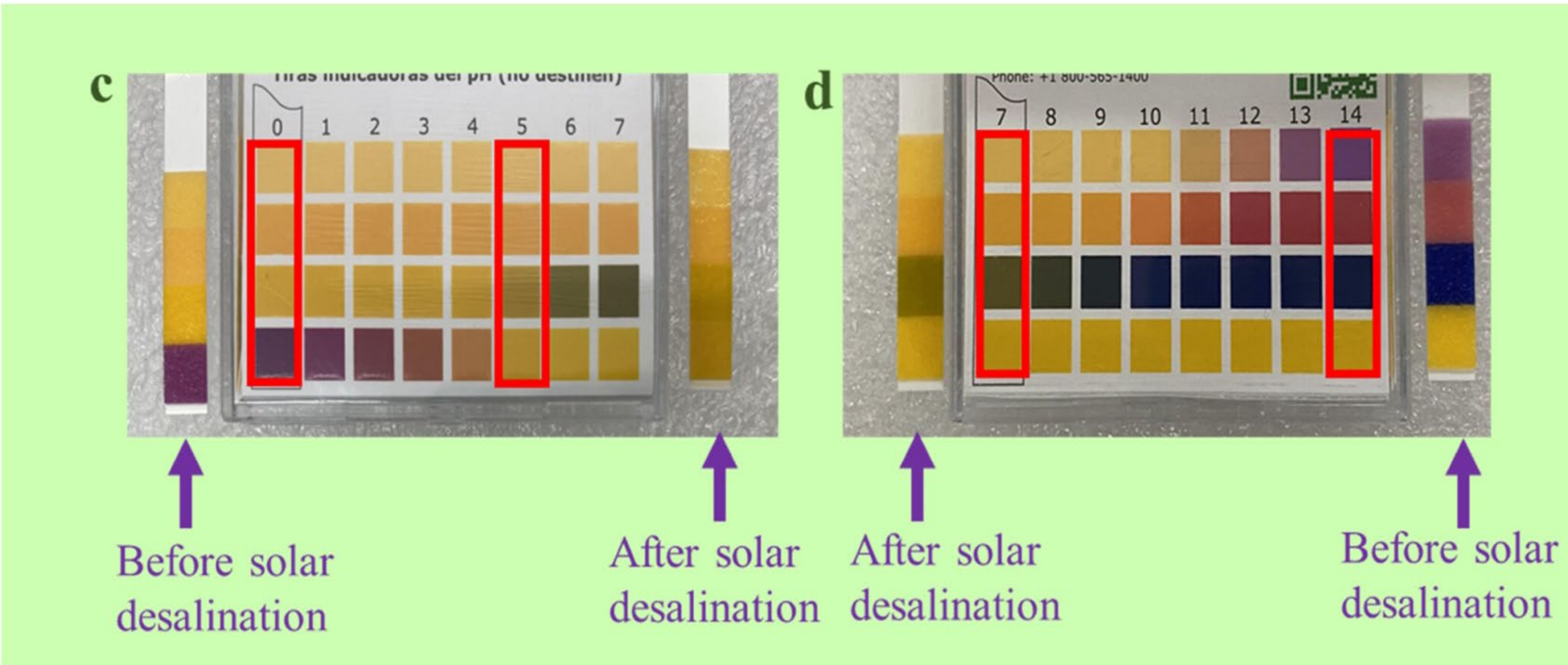


Fig: The digital images of the pH indicator for (c) acidic and (d) alkaline water before and after solar evaporation using carbonized sand.

Salt rejection ability

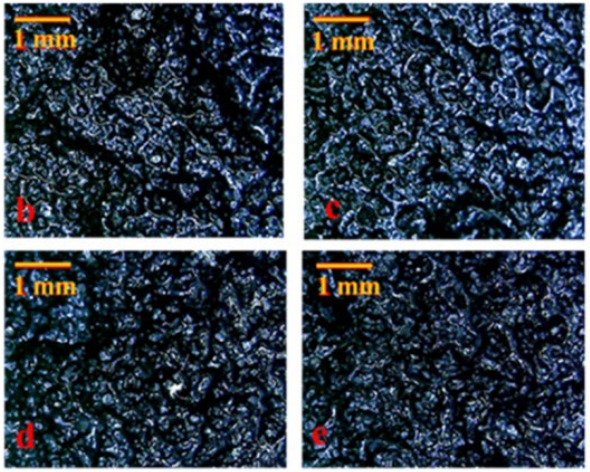


Fig: (b) Before and (c) after 1h of desalination of 3.5% solution and (d) before and (e) after 1h of desalination of 10% solution.

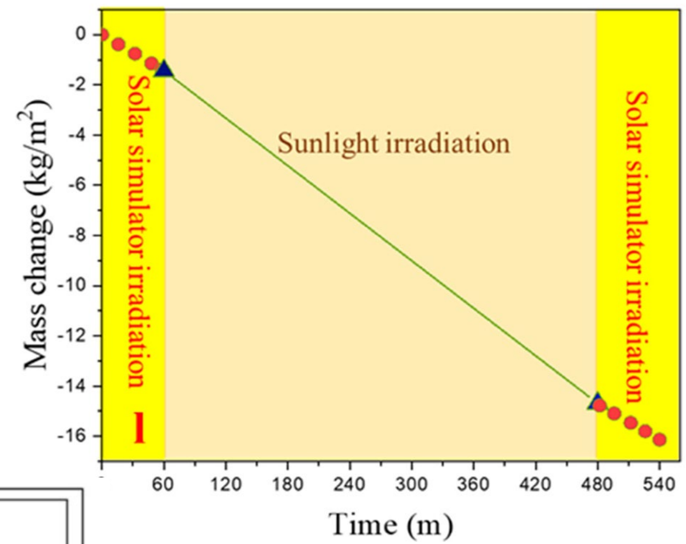


Fig: (l) Mass change of water versus time for 3.5% solution under the solar simulator and sun irradiation during 9 h of continuous irradiation.

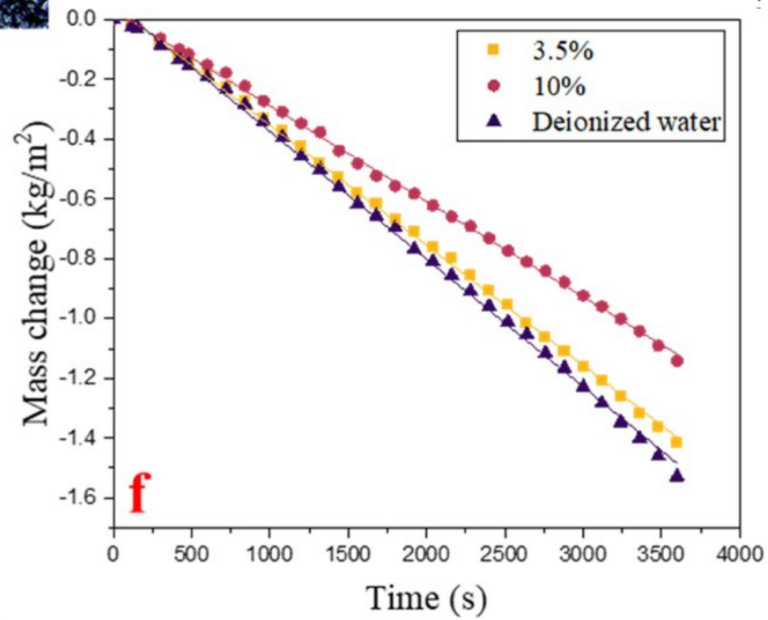


Fig: (f) Average mass change for five cycles for desalination of 3.5 and 10% of solution.

Conclusion

1. Carbonized sand has been investigated as a photo-thermal material and used in interfacial solar desalination systems.
2. It can be one of the foremost choices for photo-thermal material due to its availability, low cost, simple producing process, and efficient solar light-to-heat conversion.
3. The 3D designed system showed better efficiency (94%) than the 2D one (82%), and this is mainly because of the geometrical shape which can absorb the sunlight maximally at any direction during the day.
4. Carbon coated sand did not show any obvious salt accumulation on its surface during the solar desalination of seawater.
5. The system is capable to purify and desalinate dyed water and simulated seawater was tested, and results indicate that the salinity of collected water meets the standards of WHO for drinkable water and dyed water was completely purified.
6. All in all, it can be inferred that this system with accessible precursor materials, simple design, and without complicated processing may provide an opportunity for future fabrication of solar steam generation in large-scale and real systems.

Thank you