Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Enhanced adsorption-based atmospheric water harvesting using a photothermal cotton rod for freshwater production in cold climates

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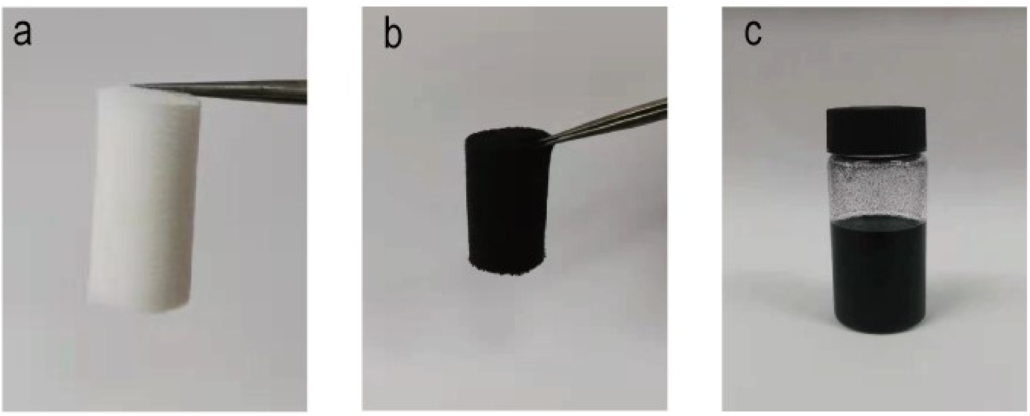

Fig. S1 The optical photos of (a) raw cotton rod, (b) CNTs-CILs@cotton rod, (c) CILs and CNTs suspension.

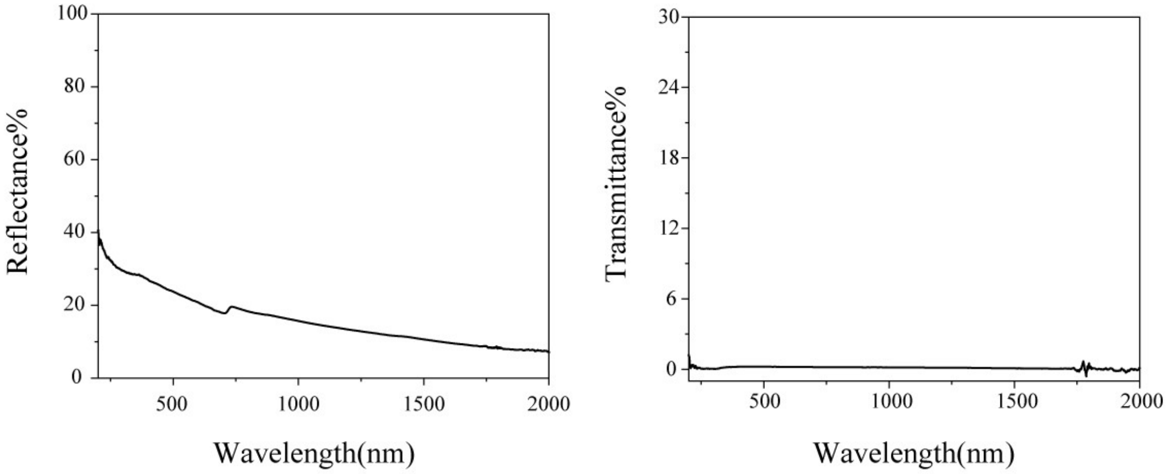

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Fig. S2 The reflection and transmission spectra of CILs-CNTs mixtures.

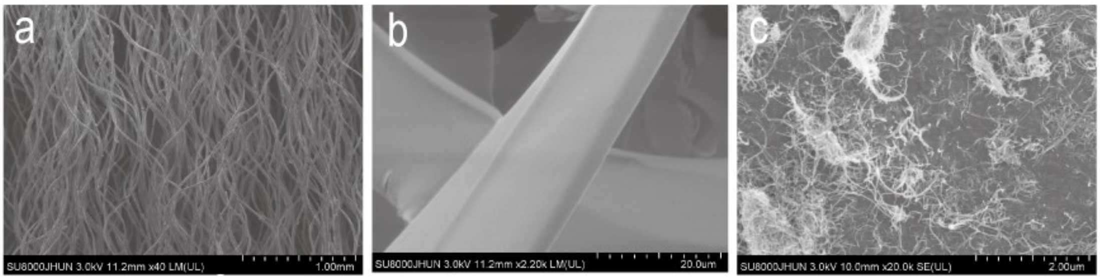
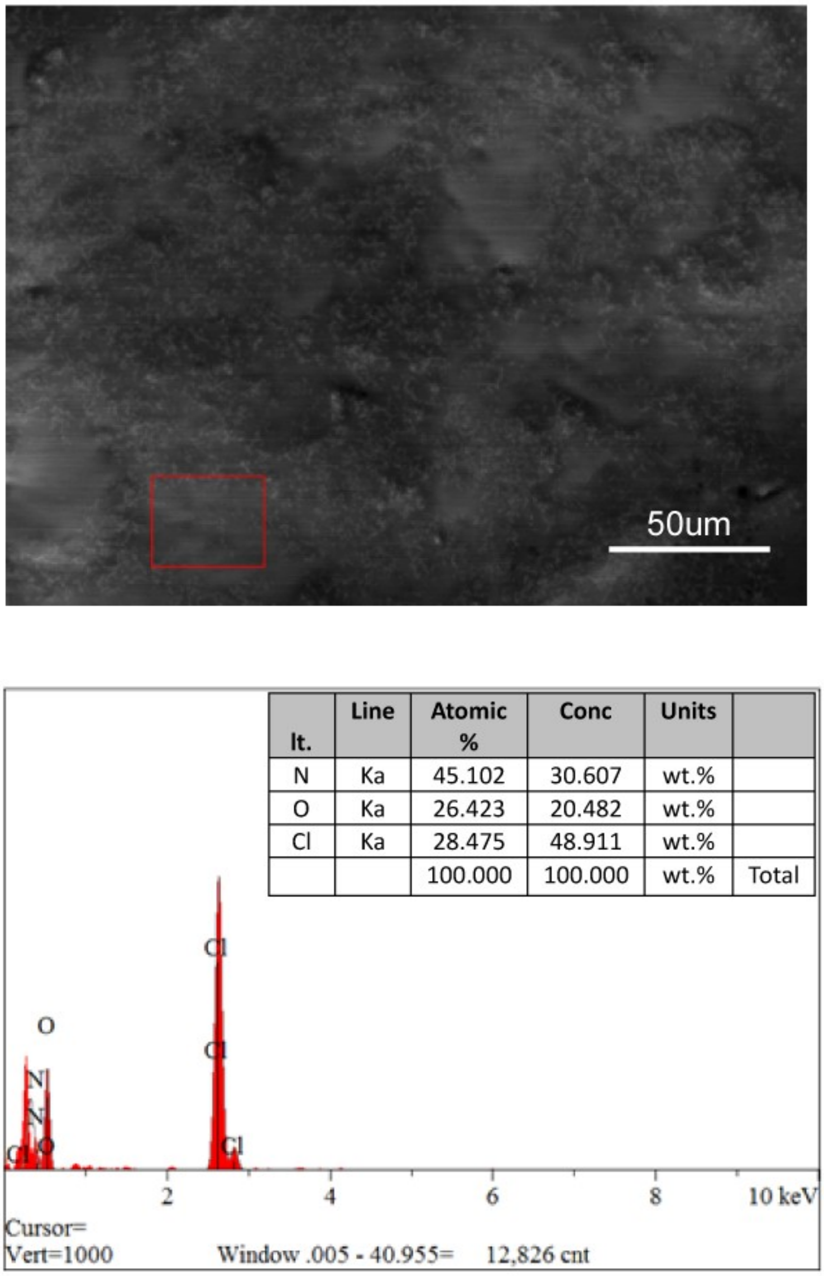


Fig. S3 The SEM of the (a), (b) raw cotton fiber, (c) carbon nanotubes on cotton fiber.



lt.	Line	Atomic %	Conc	Units	
N	Ka	45.102	30.607	wt.%	
O	Ka	26.423	20.482	wt.%	
Cl	Ka	28.475	48.911	wt.%	
		100.000	100.000	wt.%	Total

Fig. S4 The SEM-EDS of CIL and CNTs mixtures.

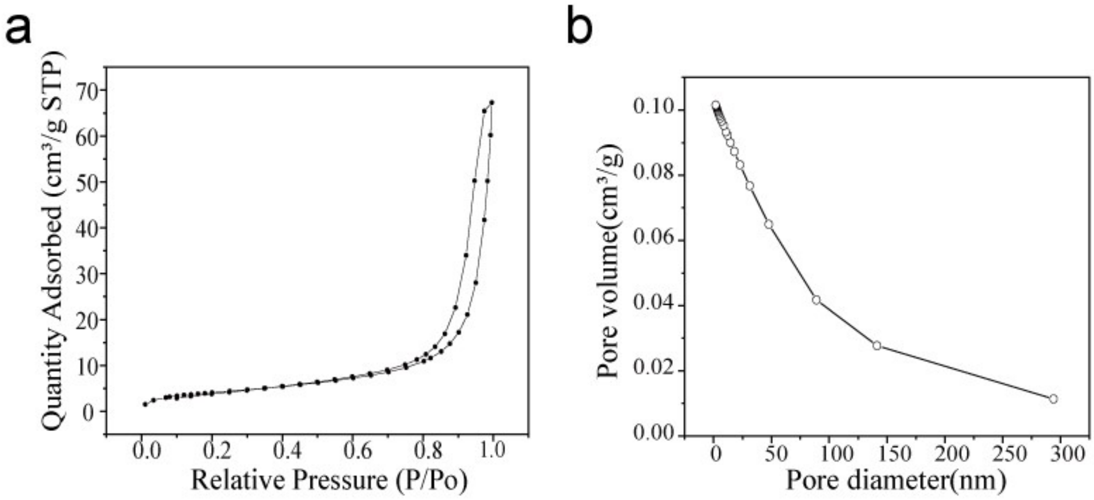


Fig. S5 (a) Nitrogen sorption isotherm of CNTs-CILs@cotton rod. (b) Pore size distribution of CNTs-CILs@cotton rod.

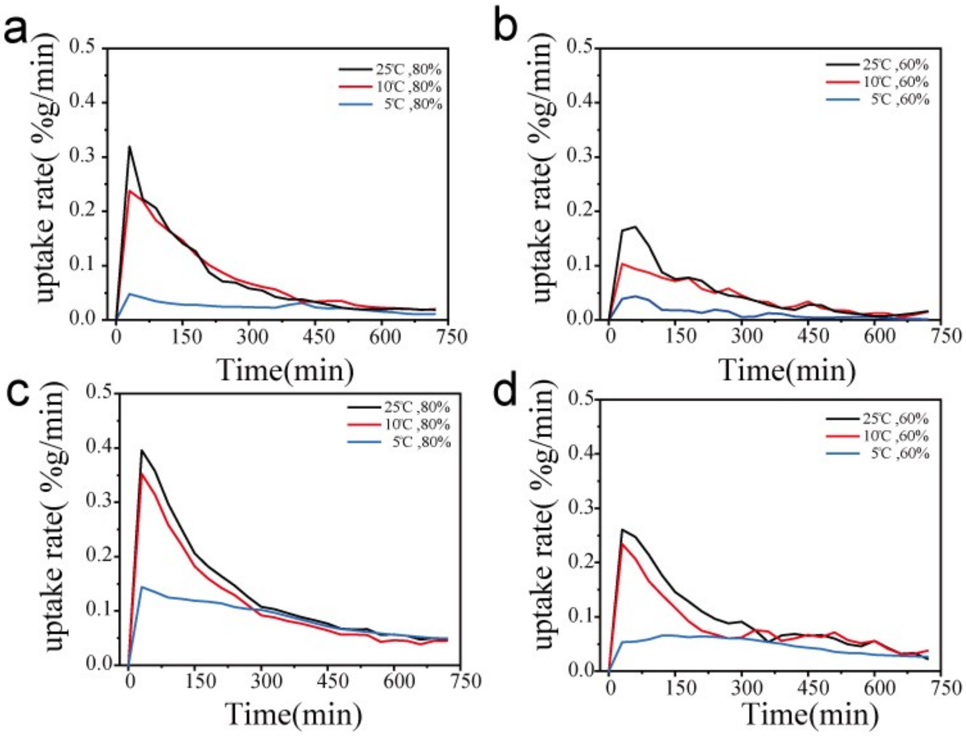


Fig. S6 The water absorption rate curves of $[C_2OHmim]Cl$ at different temperature under (a) 80% humidity, (b) 60%**.** The water absorption rate curves of CILs($[C_2OHmim]Cl$: LiCl = 7 :3) at different temperature under (c) 80% humidity, (d)60%.

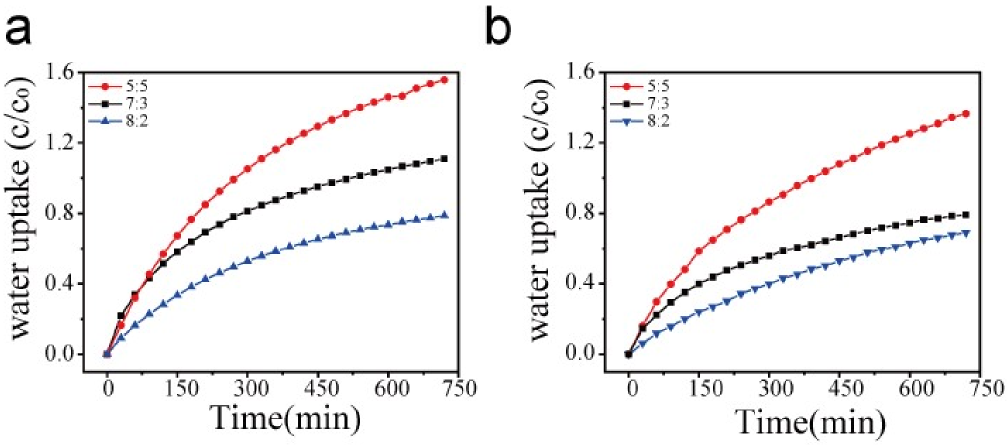


Fig. S7 The water absorption curves of C_2OHmim]Cl/LiCl composite (the ratio of C_2OHmim]Cl/LiCl = 5:5, 7:3 and 8:2) at (a) 25 °C and RH~80%, (b) at 10 °C and RH~80 %.

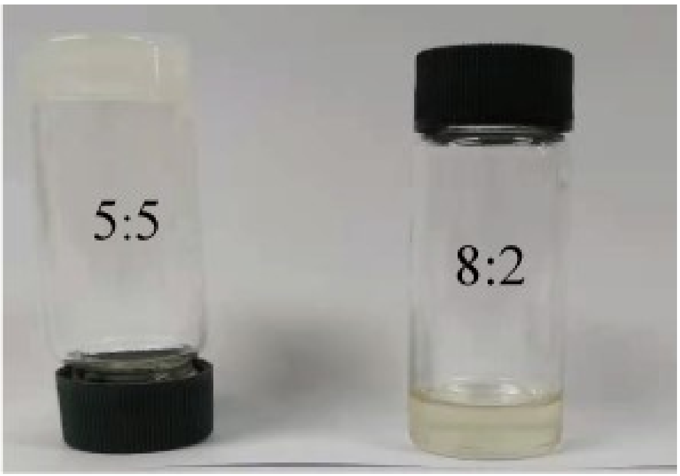


Fig. S8 The optical photos of different [C_2OHmim]Cl/LiCl ratio

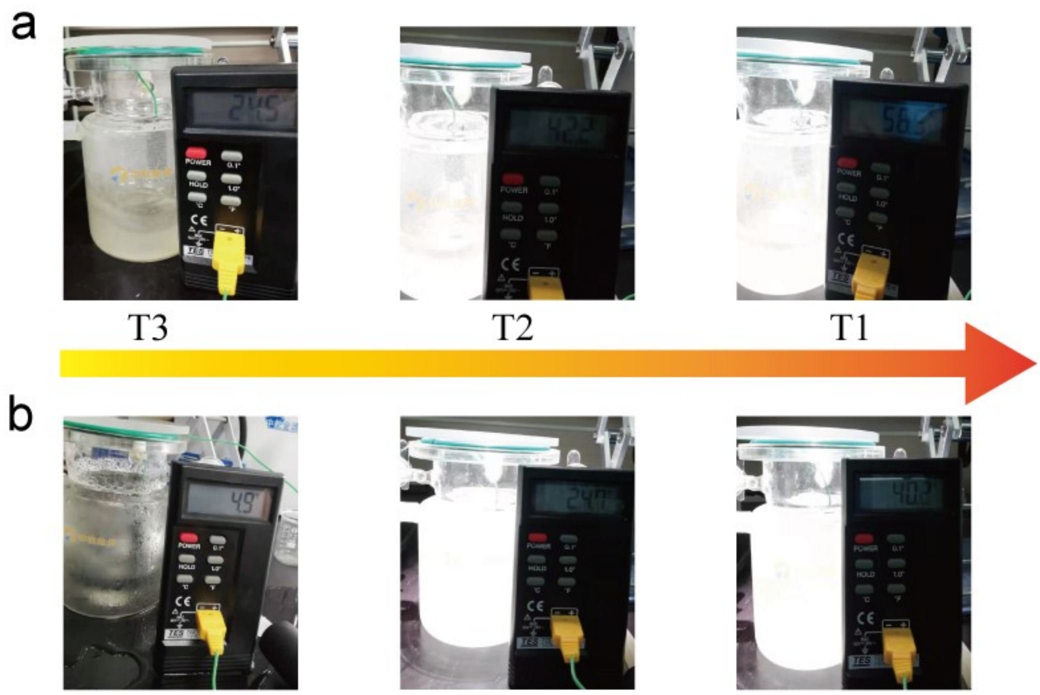


Fig. S9 The optical photos of the CNTs-CILs@cotton temperature measurements by using thermistor probe at environmental temperature of (a) 25 °C, (b) 5 °C under solar irradiation

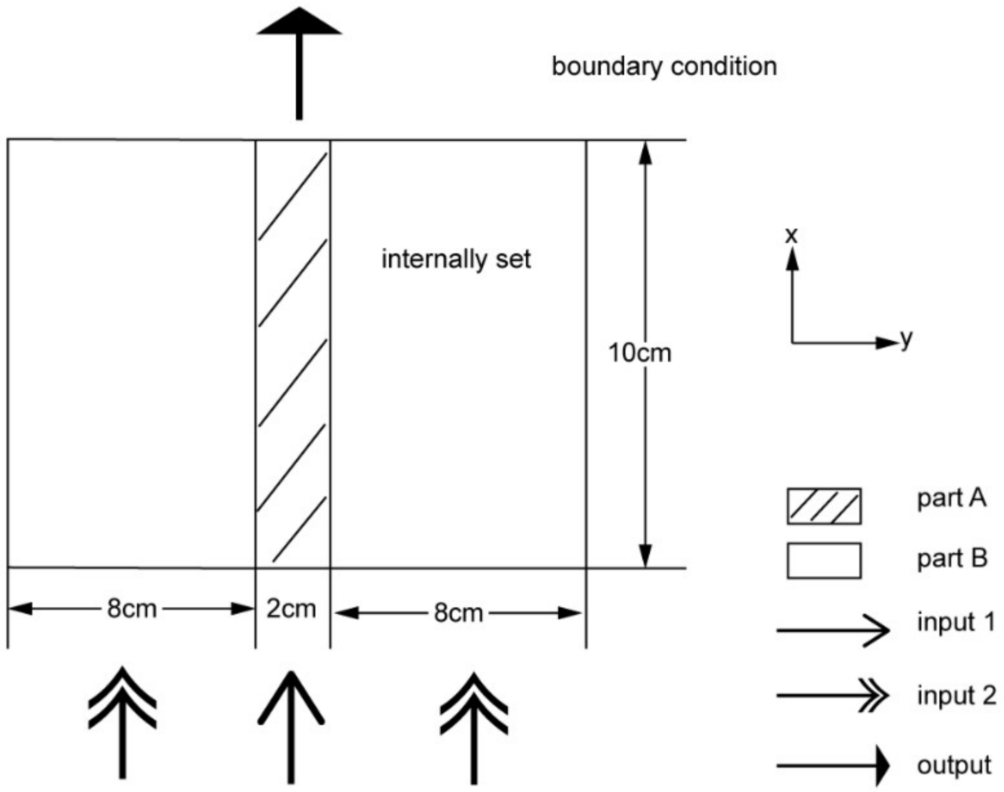


Fig. S10 The scheme of heat flow simulation.

The heat flow over the model was simulated by using CDF software (FLUENT). The temperature distribution over the airflow system was simulated by the heat transfer and turbulence model. The boundary condition includes the input 1, input 2 and output which simulated heat flow of air flow and heat energy as shown in Supporting Figure 1. In input 1, the air velocity is 0.01 m/s, the temperature is 350 K which simulated heat flow of cotton rod. In input 2, the air velocity is set 0.01 m/s, the temperature is 300 K which simulated heat flow of environment. In output, the the air velocity is 0 m/s, the temperature is 300 K. Input 1 associates with part A and input 2 associates with part B. The internally set includes material model and simulation formula. Part A is porous corban material with 0.1 of porosity. The pores are filled with air. Part B is air. In Part A, relative velocity resistance formulation and viscous resistance (inverse absolute permeability) are used to simulate. The viscosity resistance parameter is 3*109 in X axis, 3*107 in Y axis. The inertial resistance parameter is 15000 in X axis, 1500 in Y axis. This part has added in supporting information.

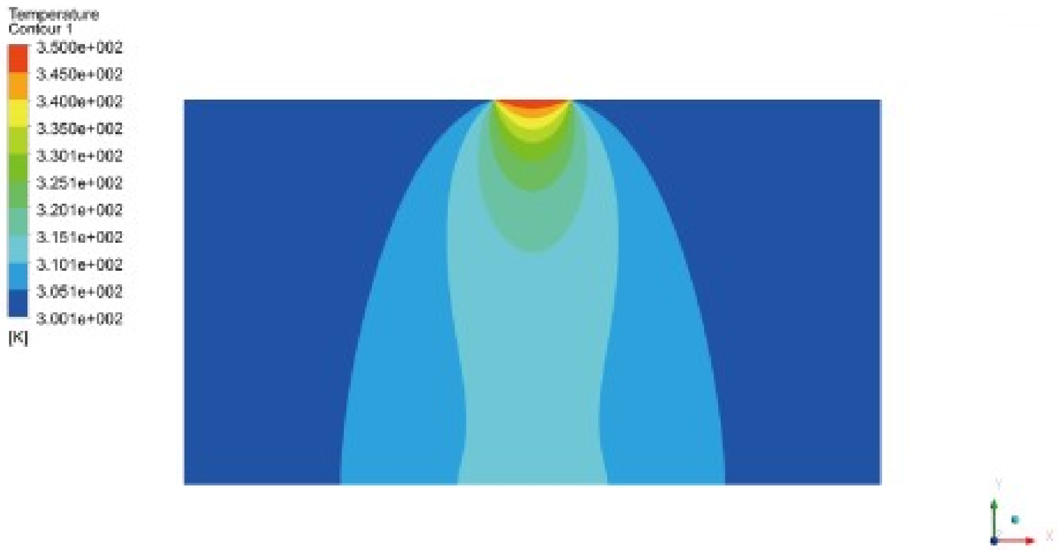


Fig. S11 The heat flow simulation image in air when T1 is 350 K.

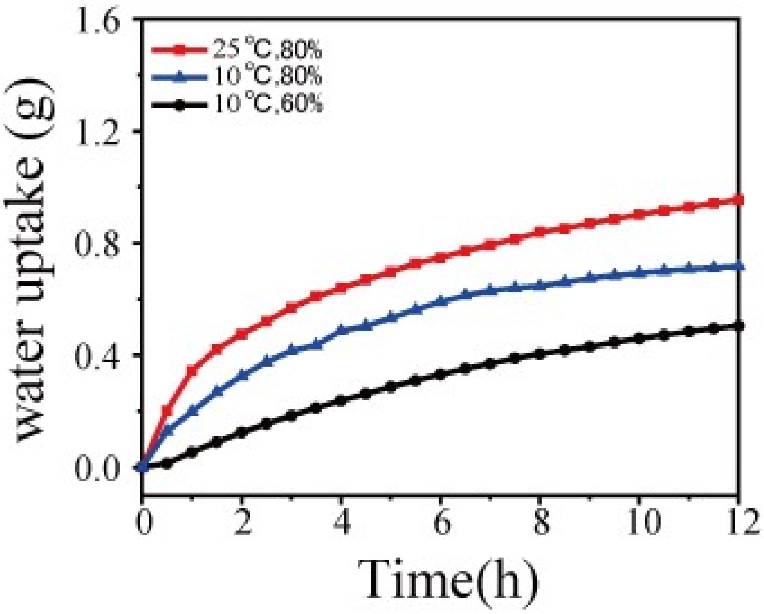


Fig. S12 The mass increase of the CNTs-CILs@cotton rods after water sorption in different temperature and humidity.

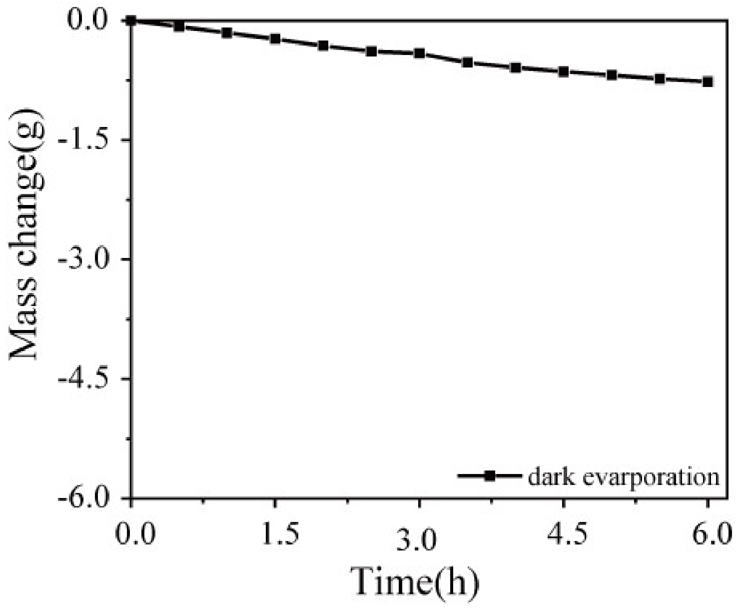


Fig. S13 Mass change of wet CNTs-CILs@cotton rod in dark condition.

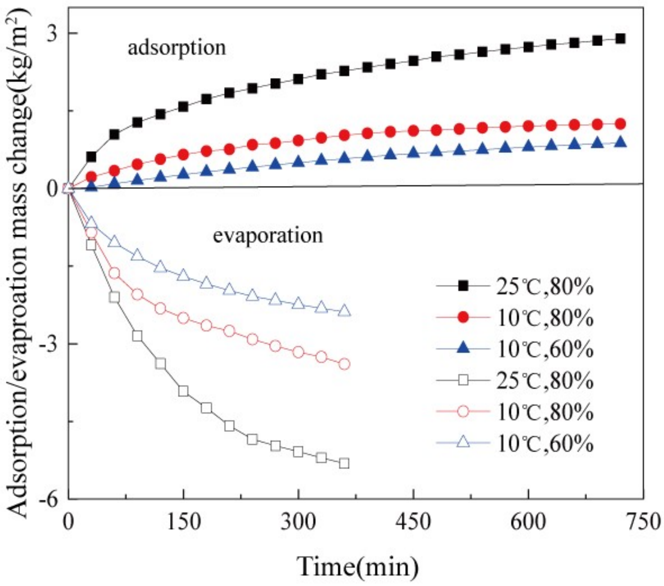


Fig. S14 The water absorption/evaporation curves of CNTs-CILs@cotton rod at different condition.

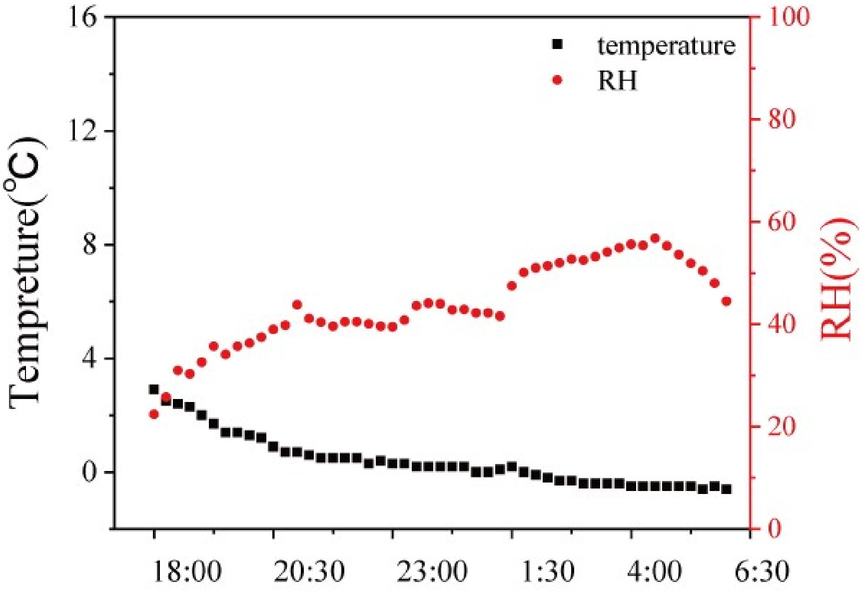


Fig. S15 The variety of environmental temperature and relative humidity changes during the ABAWH device water absorption in nighttime.

Table S1. The summary of literature on liquid sorption atmospheric water adsorption.

Reference	Sorbent	Working conditions	Water adsorption
Heshan Qi et al.[1]	[EMIM][Ac]	RH=80%,12h	1.18g/g_o
Heshan Qi et al. [1]	LiCl saturated solution(40 wt%)	RH=80%,12h	1.0g/g_o
Renyuan Li et al.[2]	$CaCl_2$ saturated solution(50 wt%)	RH=60%,12h	0.48g/g_o
Yuanyuan Cao et al. [3]	[AMIM][Cl]	RH=52%,3h	0.18g/g_o
Yuanyuan Cao et al. [3]	[ABIM][Cl]	RH=52%,3h	0.12g/g_o
Feng Ni et al. [4]	glycerin	RH=90%,12h	2kg/m^2
Our work Our work	CILs CILs	RH=80%,12h(3h) RH=60%,12h(3h)	1.6g/g(0.76g/g_o) 0.8g/g(0.56g/g_o)

References

[1] H. Qi, T. Wei, W. Zhao, B. Zhu, G. Liu, P. Wang, Z. Lin, X. Wang, X. Li, X. Zhang and J. Zhu, *Adv Mater*, 2019, **31**, e1903378..

[2] R. Li, Y. Shi, M. Alsaedi, M. Wu, L. Shi and P. Wang, *Environ Sci Technol*, 2018, 52, 11367-11377.

[3] Y. Cao, Y. Chen, L. Lu, Z. Xue and T. Mu, *Industrial & Engineering Chemistry Research*, 2013, 52, 2073-2083.

[4] Ni, F.; Qiu, N.; Xiao, P.; Zhang, C.; Jian, Y.; Liang, Y.; Xie, W.; Yan, L.; Chen, T., Tillandsia-Inspired Hygroscopic Photothermal Organogels for Efficient Atmospheric Water Harvesting. *Angew Chem Int Ed Engl* 2020, 59 (43), 19237-1924.