Supporting Information

Thermoresponsive Hydrogel-Powered Zero-Energy Greenhouse: Intelligent Shading and Water Irrigation

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3 Figures

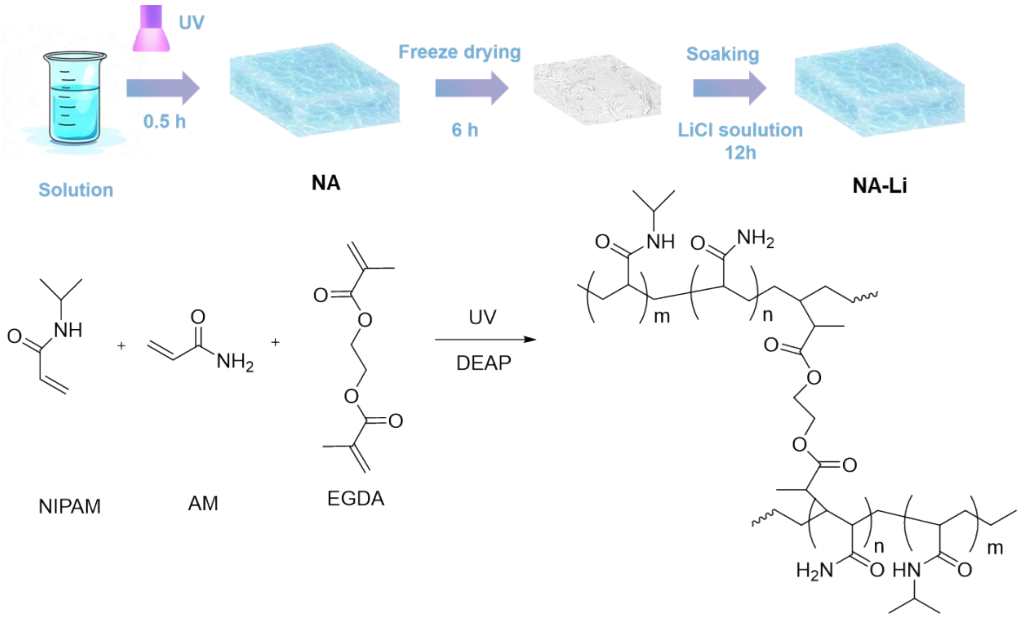

Figure S1. Schematic representation of the fabrication process of NA-Li hydrogel.

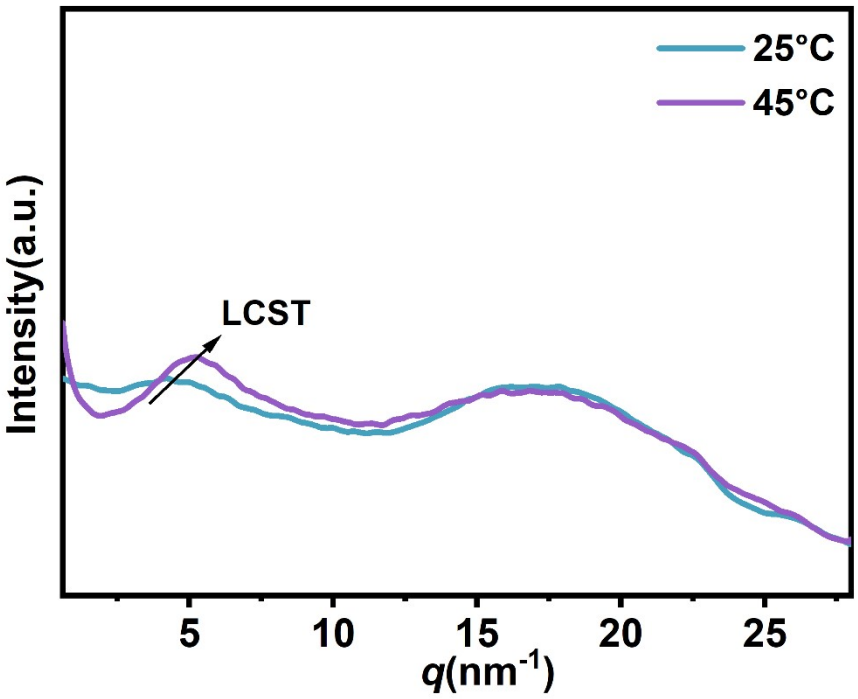

Figure S2. SAXS curves of the NA-Li hydrogel at 25 ºC and 45 ºC.

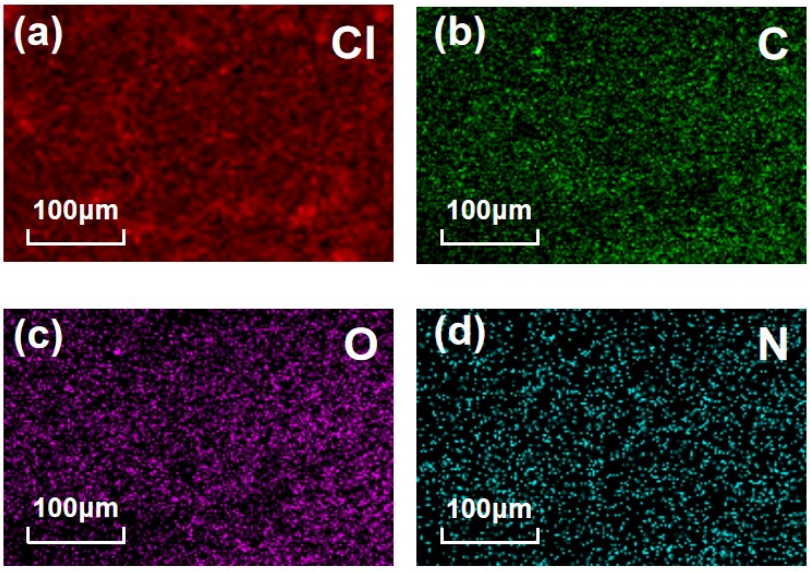

Figure S3. EDS elemental mapping showing the uniform distribution of Cl(a), C(b), O(c) and N(d) elements of the dry Na-Li.

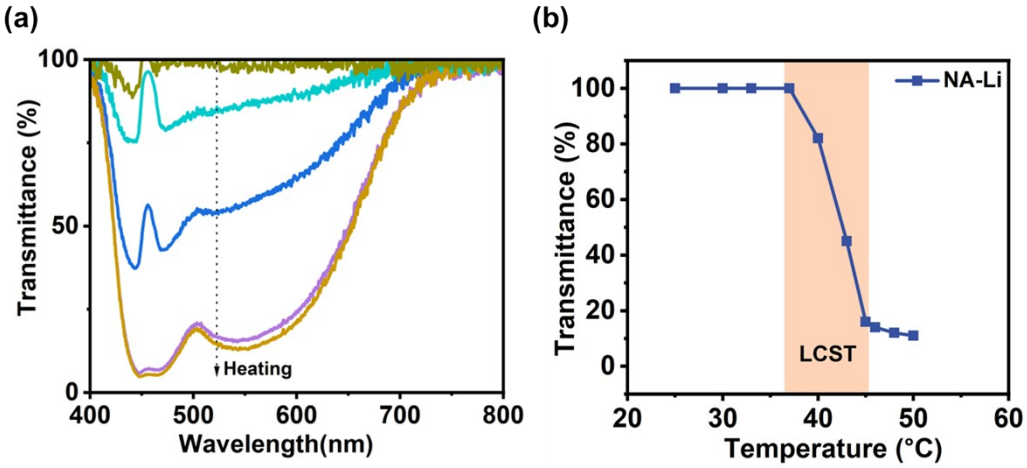

Figure S4. Temperature-dependent transmittance changes of Na-Li hydrogel upon heating process at a home-made setup (a) and the corresponding transmittance changes at 520nm (b).

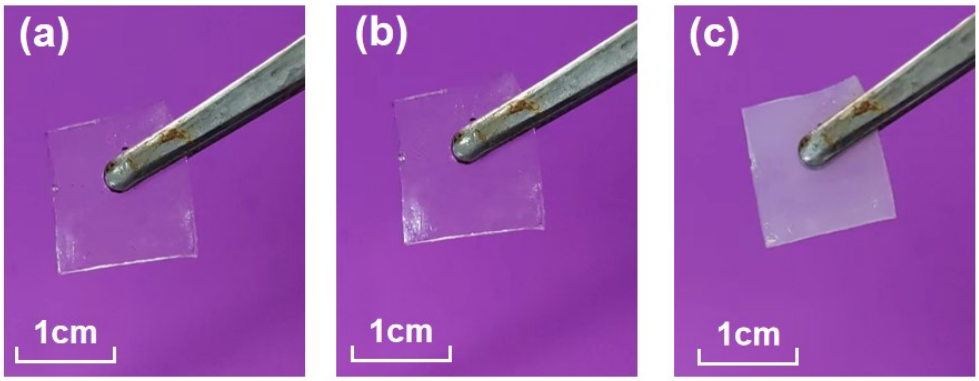

Figure S5. The digital photos of NA-Li at the temperatures of -25℃(a), 25℃(b) and 45℃(c).

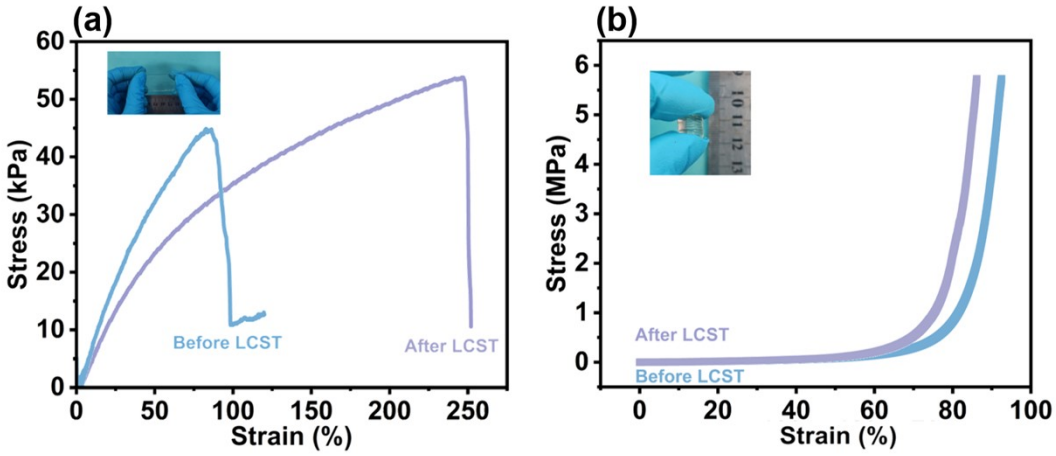

Figure S6. The stretch curves (a) and compression curves (b) of Na-Li before LCST and after LCST.

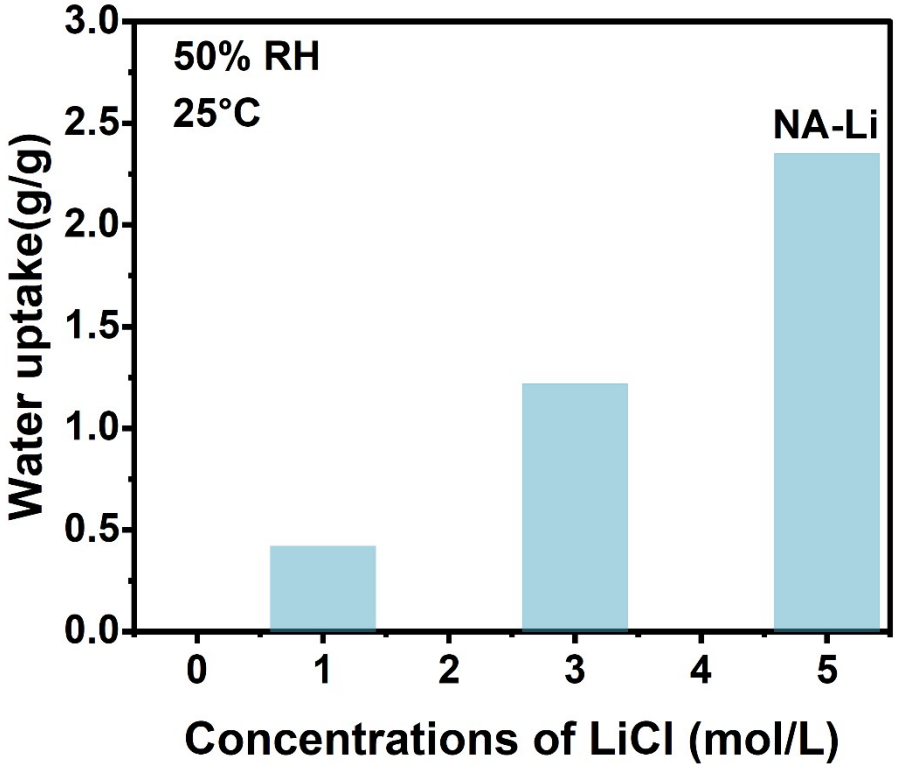

Figure S7. Water uptake of the dry NA-Li absorbents as the concentrations of LiCl are 1, 3 and 5 mol/L, respectively.

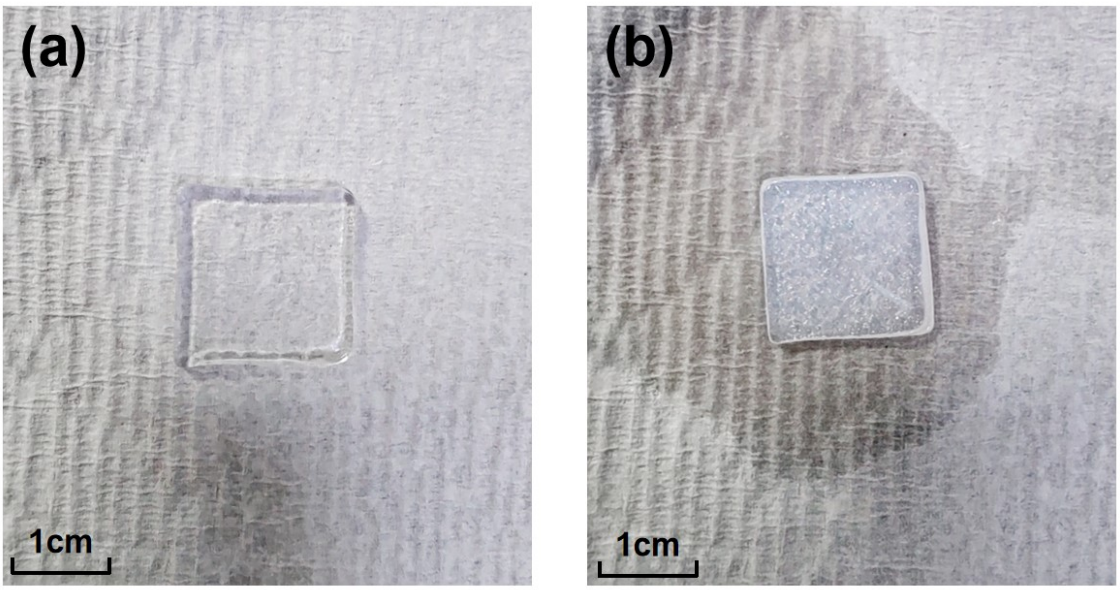

Figure S8. The pictures of NA-Li wetting the tissue: before LCST(a) and after LCST(b).

The NA-Li at 45ºC enables a rapid wetting of the tissue based on LCST switchable water generation process.

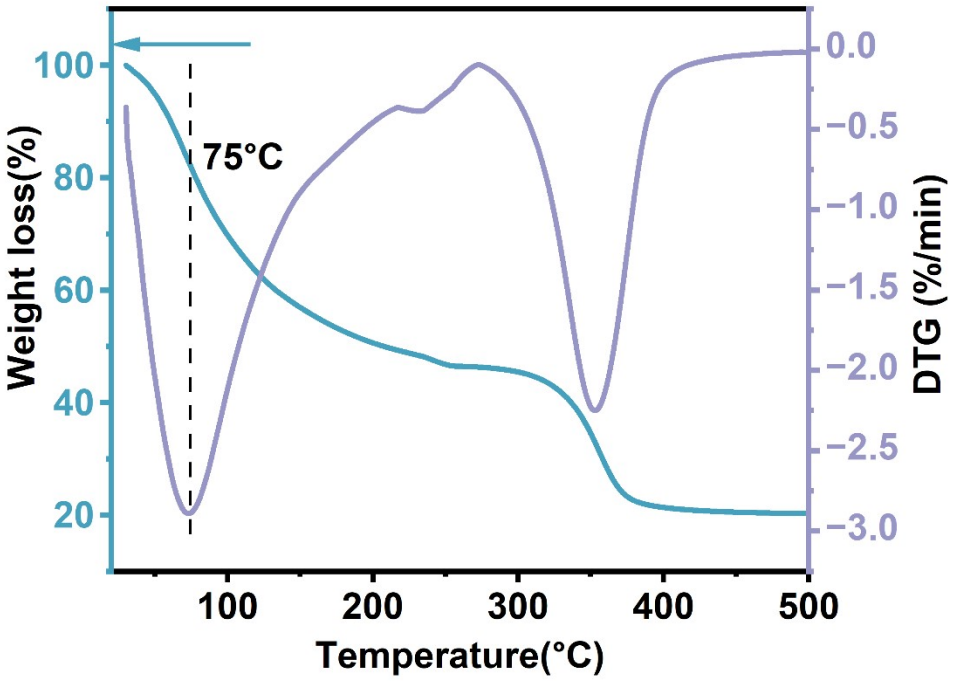

Figure S9. The TGA and DTG curves of NA-Li upon heating process at a rate of 5 ºC/min.

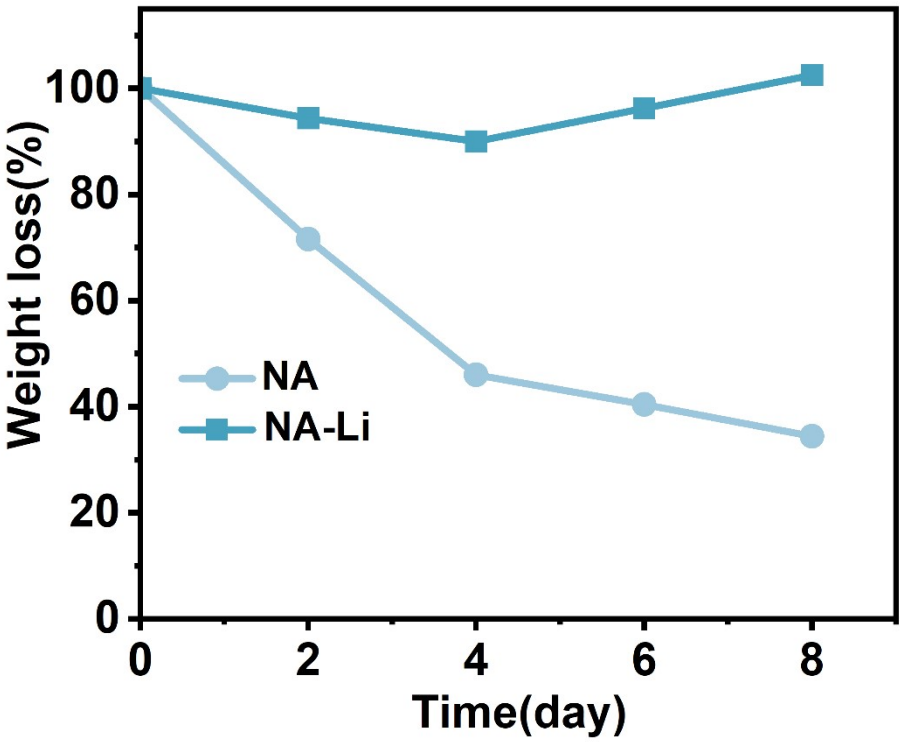

Figure S10. The weight loss of NA-Li and NA during eight days.

The weight of NA-Li remains dynamic changes with a fluctuation of ±8%, which might be from the RH-dependent water absorption properties. In contrast, the NA hydrogel without LiCl rapidly lost the weight every day, since there is barely no moisture absorption ability.

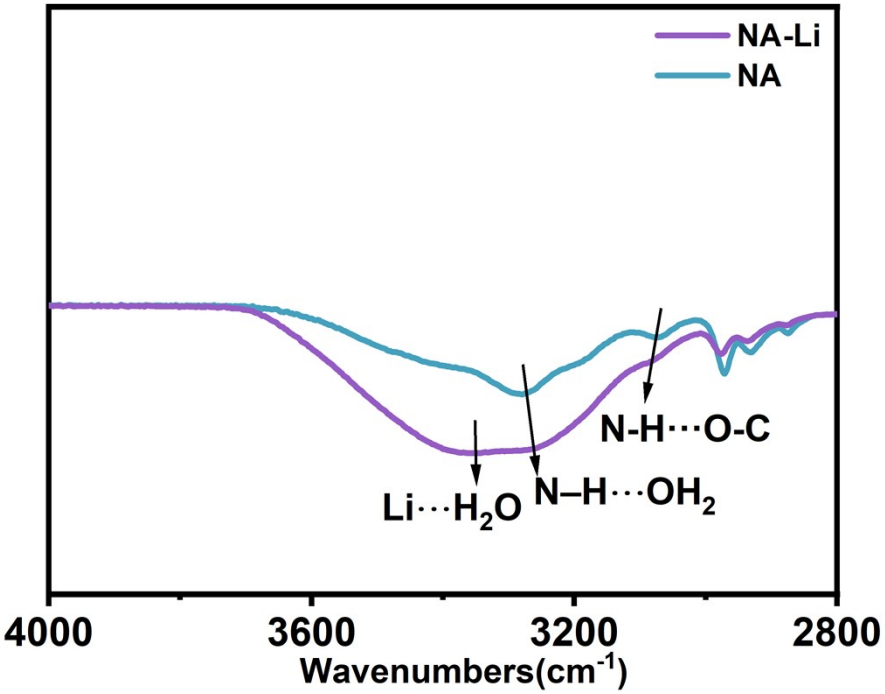

Figure S11. The FT-IR curves in the water region of NA-Li and NA at room temperature.

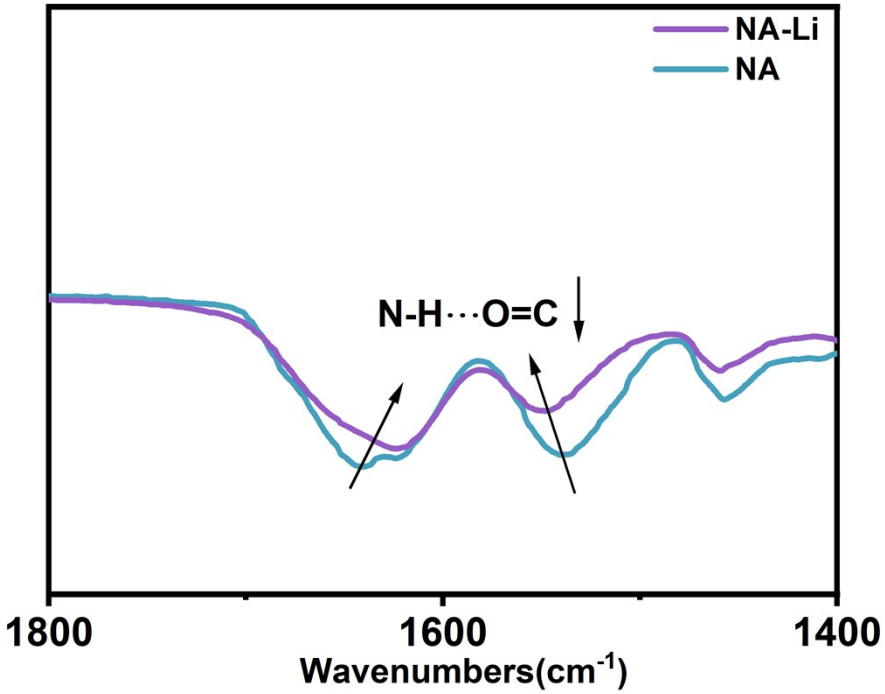

Figure S12. The FT-IR curves in the C=O region of NA-Li and NA at room temperature

Figure S13. The water collection and transport pictures of NA-Li by sewing the cotton thread in the NA-Li hydrogel.

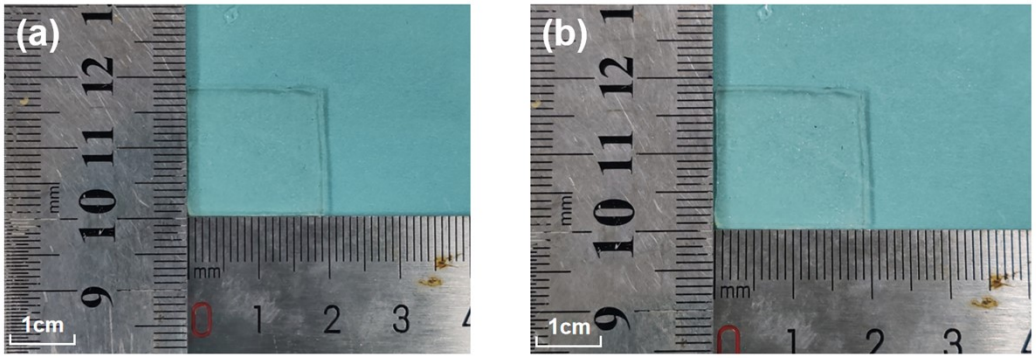

Figure S14. The pictures of the NA-Li hydrogel before (a) and after (b) one year

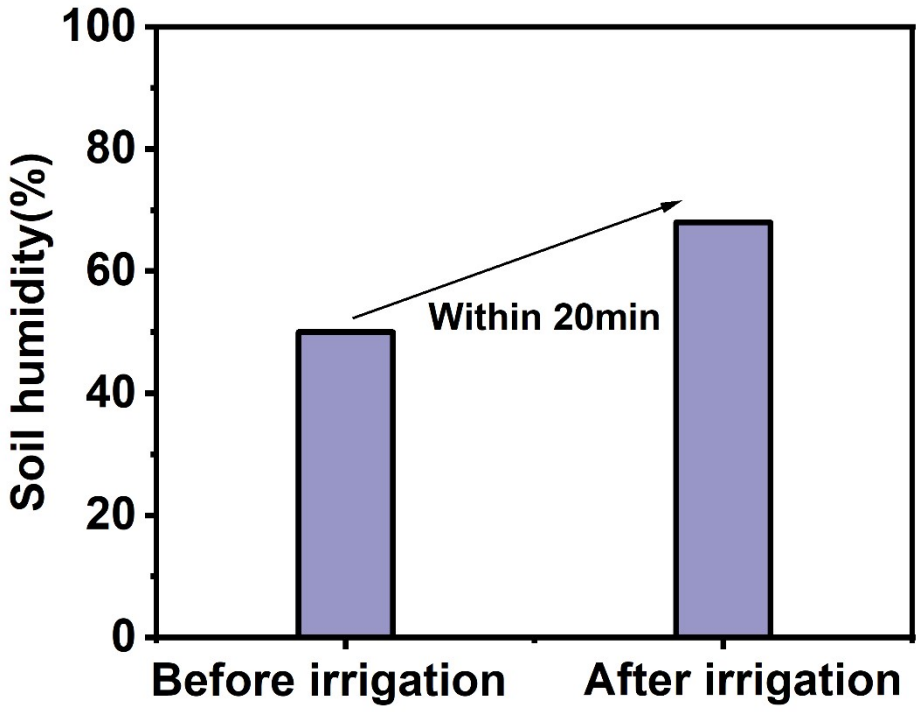

Figure S15. Increased soil humidities from 51 to 68% from the water desorption process of the NA-Li.

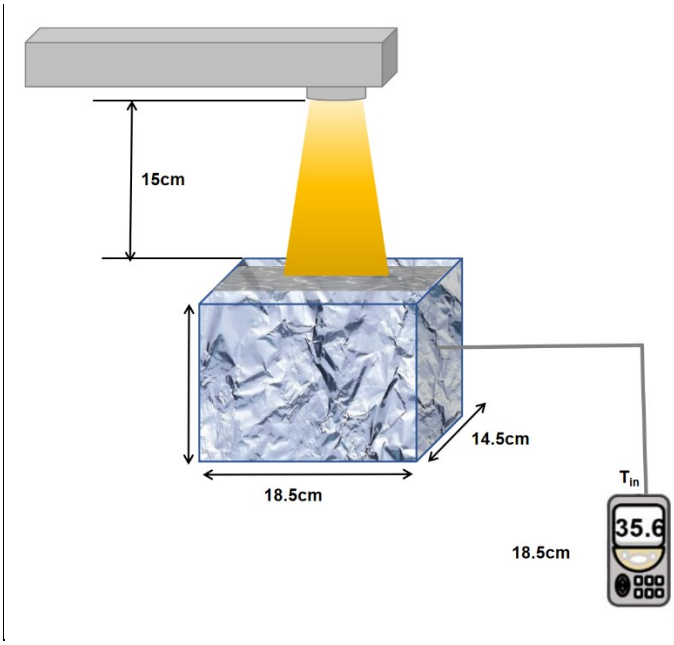

Figure S16. Schematic illustration of the model house under simulated sunlight with an intensity of 1.0 Sun.

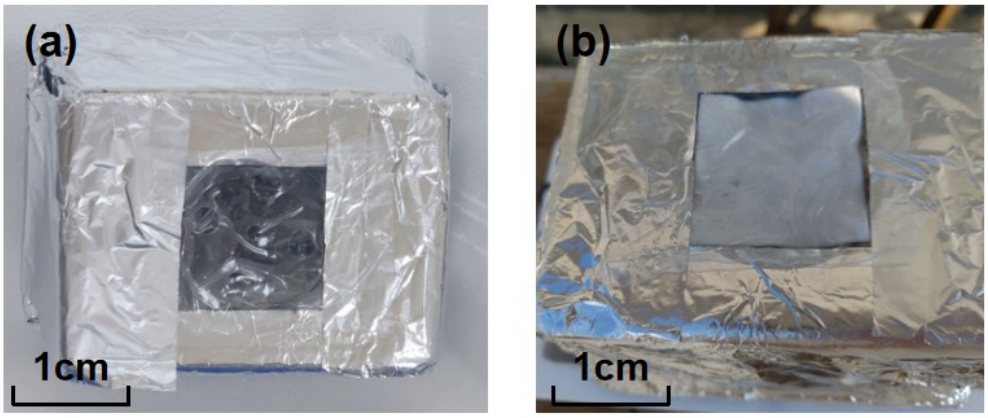

Figure S17. The digital photos of the NA-Li window with switchable turbidity changes: before LCST(a) and after LCST(b) under real sun irradiation.

Figure S18 The digital photo of the outdoor experiment in Chongqing.

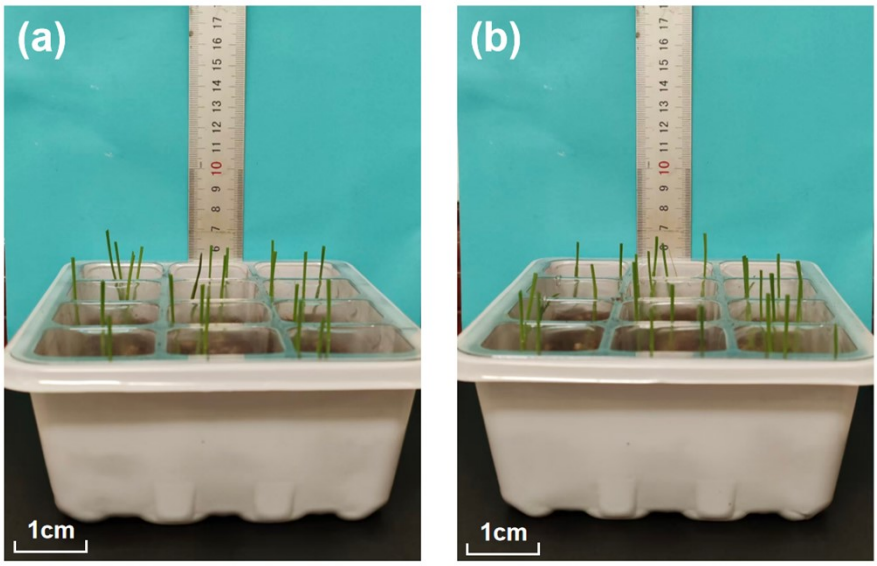

Figure S19 The Hordeum vulgare germinated indoors for 3 days: (a) the samples for PVC covered greenhouse; (b) the samples for Na-Li covered greenhouse.

Figure S20. The turbid NA-Li window under the natural sun irradiation for greenhouse experiment.

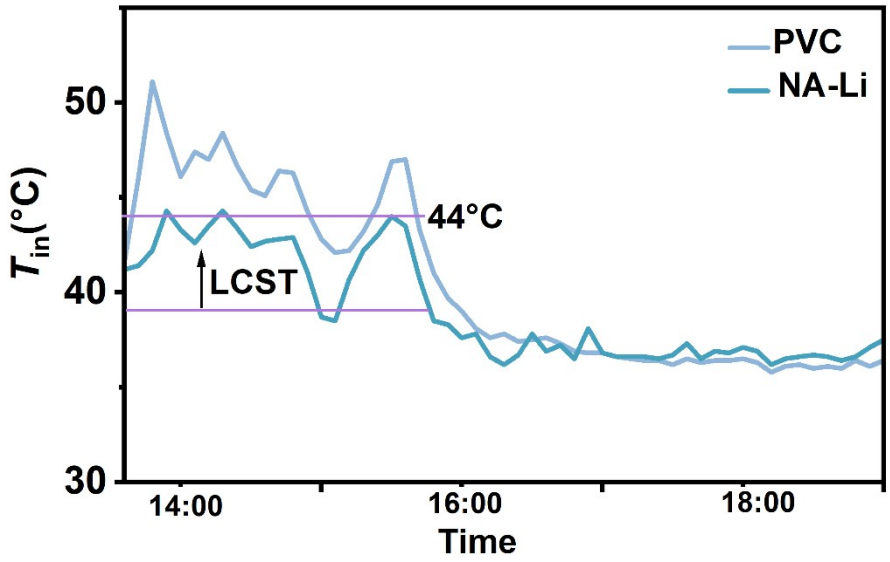

Figure S21. The inner temperature changes for PVC and NA-Li greenhouses during afternoon on 0905, 2025 in Chongqing, China.

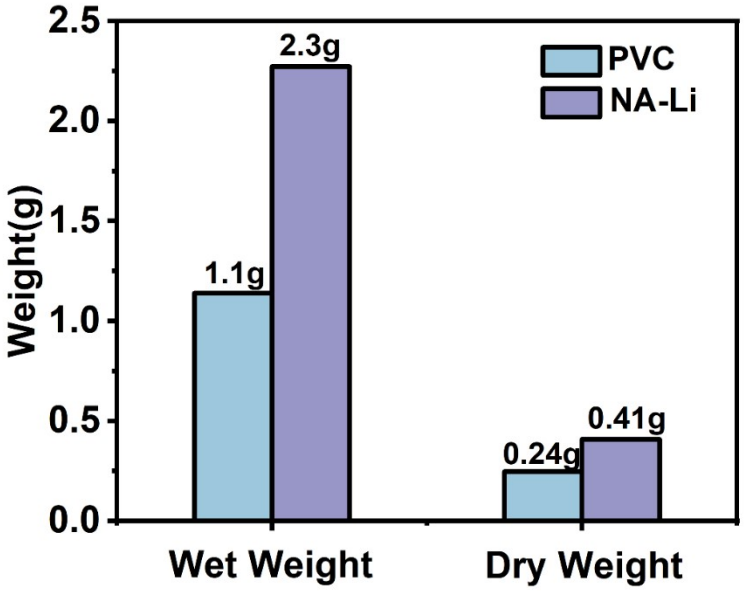

Figure S22 The wet and dry weights of Hordeum vulgare under NA-Li and PVC covered greenhouses, respectively.

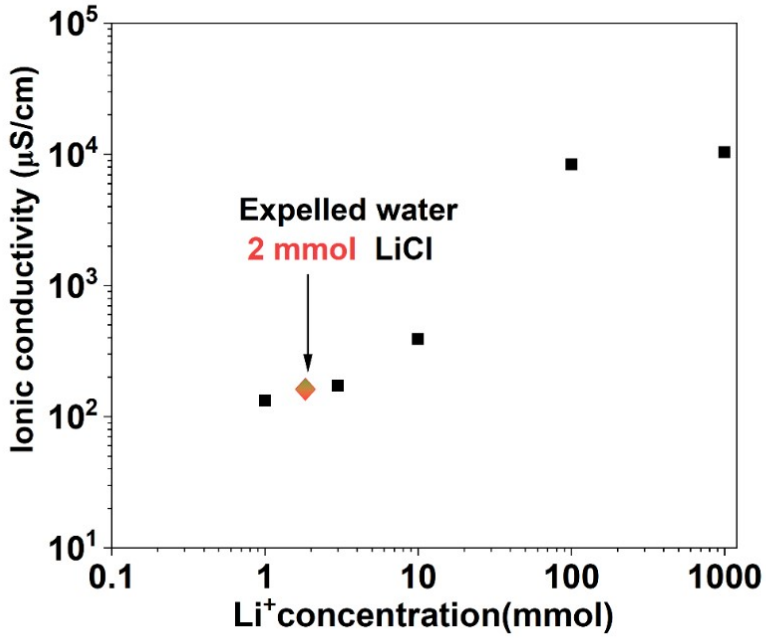

Figure S23 The ionic conductivity of the LiCl aqueous at various concentrations from 1 mmol to 1 mol.

Table S1 Water adsorption and desorption performance in comparing with reported literatures.

Materials	RH /Temperature	Water uptake (g/g)	Water uptake rate (g/g·h)	Desorption water (g/g)	Desorption water rate (g/g·h)	References
CNF-LiCl	30%/25℃	0.73	0.061	Liquid（0.4）	0.2	1
MXene/CNF/LiCl	30%/30℃	1.14	N/A	Vapor（1.08）	N/A	2
CNFN/LiCl	30%/25℃	1.36	0.25	Vapor（N/A）	N/A	3
PIL/PNIPAm/LiCl	30%/25℃	1.08	0.43	Vapor (0.82)	0.41	4
CNF/LiCl	45%/25℃	1.70	0.28	N/A	N/A	5
COF/LiCl	45%/25℃	0.37	0.15	Vapor (0.37)	0.37	6
PNIPAm/LiCl/CN	30%/25℃	3.96	0.56	Vapor (2.89)	0.96	7
PNIPAm/HPC/LiCl	70%/25℃	1.45	0.15	Vapor (N/A)	N/A	8
PNIPAm/PPy/$CaCl_2$	40%/25℃	2.50	0.25	Vapor (2.5)	2.5	9
HPC/LiCl/TiN	60%/30℃	1.79	1.79	Vapor (1.79)	3.5	10
PNIPAm/AM/LiCl	**40%/25℃**	**1.93**	**0.32**	**Liquid (1.0)**	**1.0**	**This work**

N/A means unknown

Table S2 Overall performance in comparing with previously reported SAWH in greenhouse.

Name	AWH capacity ($g\ g^{-1}$)	Water-saving capacity ($g\ m^{-2}$)	Energy consuming	Plant safety	Optical control	References
SmartFarm	2.24	746.7	Passive	Minor Harm	No	11
$CaCl_2$@SG	0.71	483	Very high	No harm	No	12
WEC^2P	0.57	629.6	High	Almost No Harm	No	13
TEAD	3.38	1832.5	Passive	No harm	No	9
PDA@PP-Cl	1.61	1420	Passive	Minor Harm	Yes	14
LCST/LiCl	**1.3**	**1020**	**Very passive**	**Minor Harm**	**Yes**	**Our work**

References

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