Direct Laser Writing Carbonization of Polyimide Films Enabled Multilayer Structures for the Use of Interfacial Solar-Driven Water Evaporation

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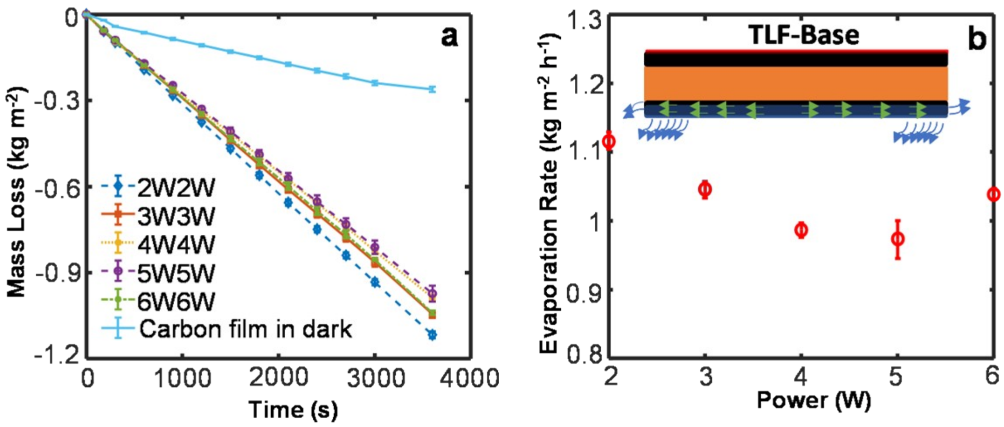


Figure S1. Mass loss (a) and the water evaporation rate (b) of the TLF-Base film (prepared by different laser powers) enabled interfacial solar-driven water evaporation system when immersed in NaCl solution (3.5 wt. %) and under one-sun illumination for 1 hr. Inset in (b) schematically shows the vapor generation sites for the TLF-Base film.

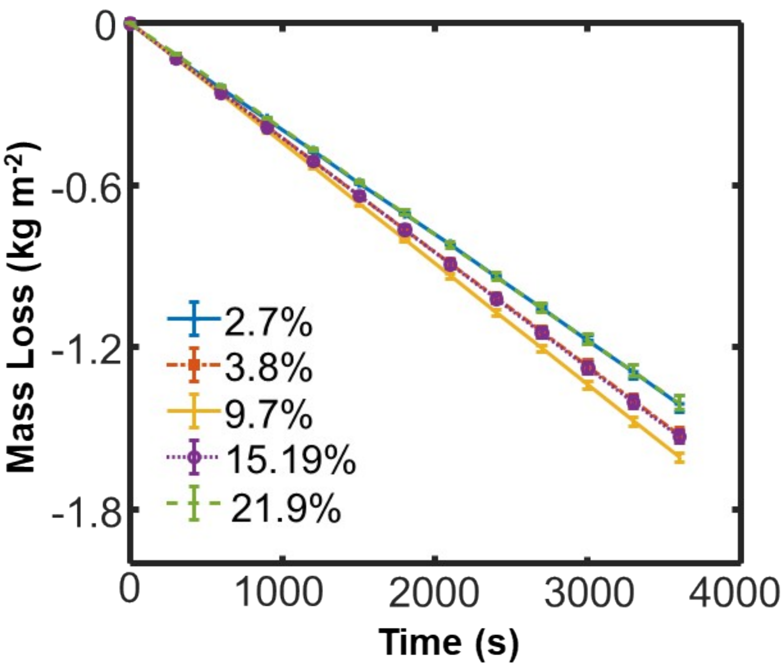


Figure S2. Mass loss results of the NaCl solution (3.5wt%) for the 2W TLF enabled interfacial solar-driven water evaporation system under one-sun illumination for 1 hr. The legend indicates the value of the hole opening areal fraction.

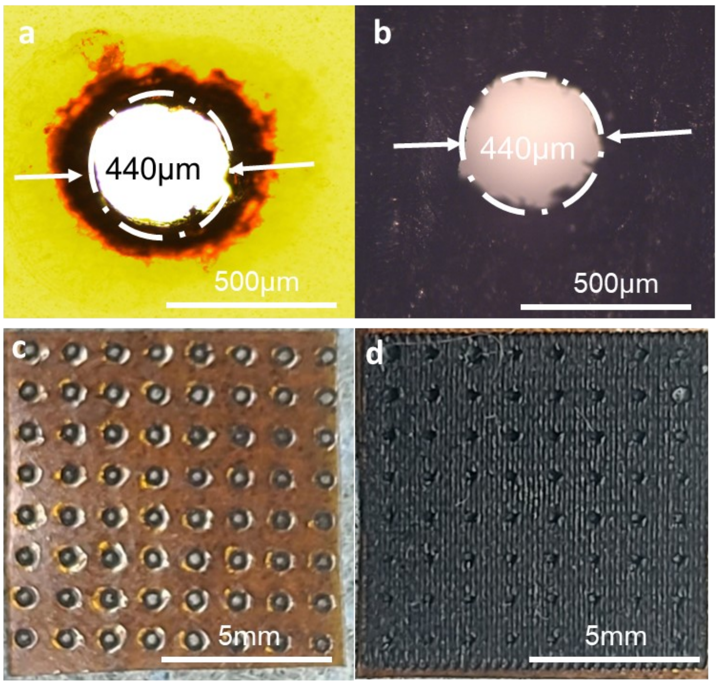


Figure S3. Optical graphs to show the size and the arrangement of the holes in a 2 W TLF system. (a, c) Holes on the PI film before DLWc process; (b, d) Holes on the carbon/PI/carbon tri-layer film after DLWc process.

Table S1 Square-arrayed hole parameters used in creating TLF films

Arrangement of holes	The spacing of holes	Proportion of holes area
4*4	2.5 mm	2.4 %
5*5	2 mm	3.8 %
8*8	1.3 mm	9.7 %
10*10	0.9 mm	15.19 %
12*12	0.8 mm	21.9 %

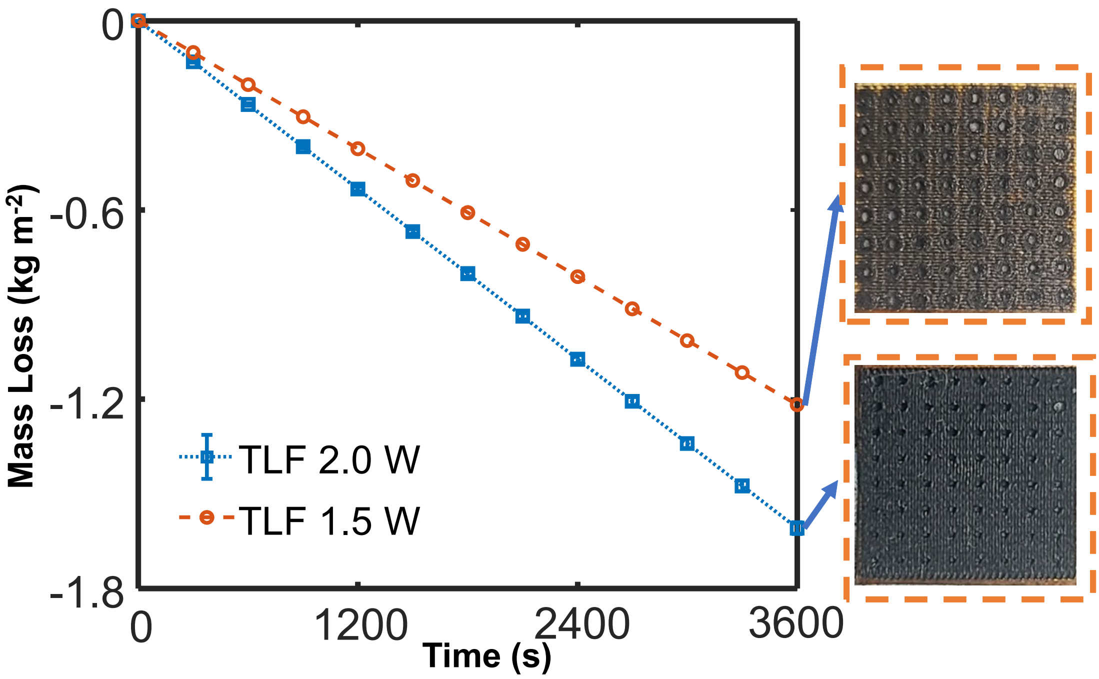


Figure S4. Comparison on the mass loss results of the NaCl solution (3.5 wt. %) for the 2 W and 1.5 W TLF enabled interfacial solar-driven water evaporation system under one-sun illumination for 1 hr. The water evaporation rates are 1.61 and 1.22 kg m^{-2} h^{-1}, respectively. Insets are the optical images of the DLWc created light absorbing layer respectively created at 1.5 W and 2 W.

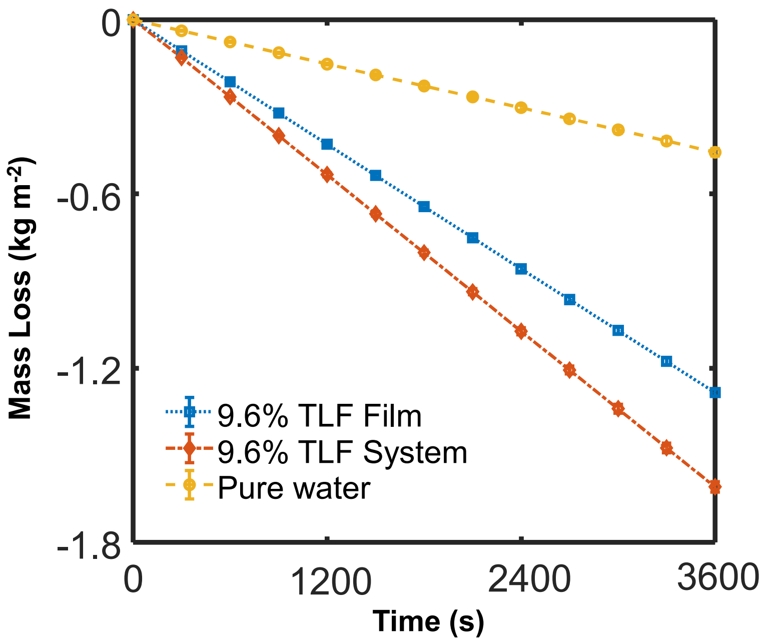


Figure S5. Comparison on the mass loss results of the NaCl solution (3.5 wt. %) for the 2 W TLF system (assembled with PU foam and filter paper), 2 W MTLF film (self-floating on the NaCl solution), and pure NaCl solution under one-sun illumination for 1 hr. The water evaporation rates are 1.61, 1.28 and 0.46 kg m^{-2} h^{-1}, respectively.

Table S2 Sample size information for the DLWc processed multi-layer films used in TLF-Base, TLF and BLV interfacial solar-driven water evaporation systems (see Figure S7 for the definition of the geometric parameters in BLV system)

Sample	Length (mm)	Width (mm)	Apex Angle (degree)	Height (mm)
TLF-Base	10 mm	10 mm	N/A	N/A
TLF	10 mm	10 mm	N/A	N/A
30° BLV	20 mm	10 mm	30	10
60° BLV	23 mm	10 mm	60	10
90° BLV	28 mm	10 mm	90	10
120° BLV	40 mm	10 mm	120	10
150° BLV	77 mm	10 mm	150	10

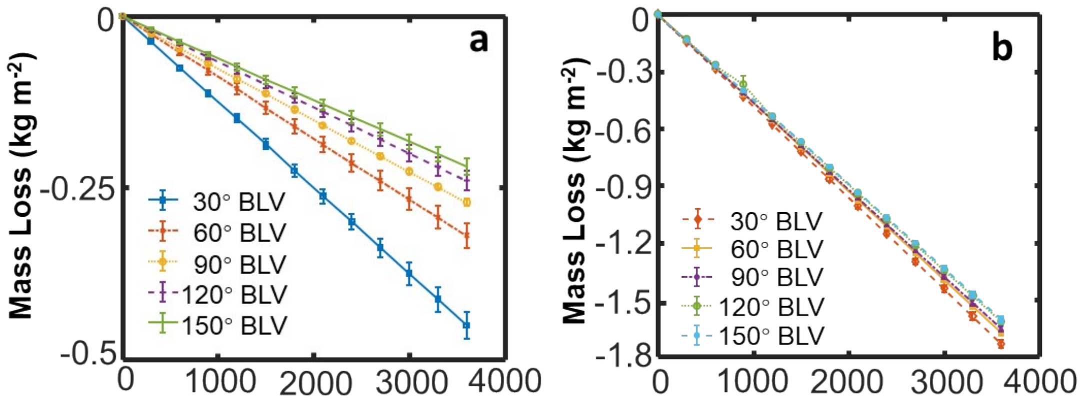
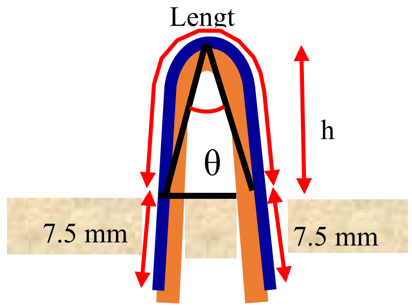


Figure S6. (a) Mass loss results of the NaCl solution (3.5 wt. %) when the BLV enabled interfacial solar-driven water evaporation system was under dark for 1 hr (b) Mass loss results of the NaCl solution (3.5 wt. %) when the BLV enabled interfacial solar-driven water evaporation system was under one-sun illumination for 1 hr



$$s = 2 * h * tan\frac{\theta}{2} * Width$$

Figure S7. Calculation of the projected floor area - *s* for a BLV system. θ and *h* are respectively the apex angle and height of the BLV system; and Length and Width are respectively the length and the width of the light absorbing carbon region. The values of θ, *h*, Length and Width for the BLV systems of different apex angles can be found in Table S2.

Table S3 Values of the projected floor area and the true area of the light absorbing layer in BLV system of different apex angles

Sample	Projected Area-s(mm^2)	True light absorbing Area (mm^2)
30° BLV	53.59 mm^2	350 mm^2
60° BLV	115.47 mm^2	380 mm^2
90° BLV	200 mm^2	430 mm^2
120° BLV	346.41 mm^2	550 mm^2
150° BLV	746.41 mm^2	920 mm^2

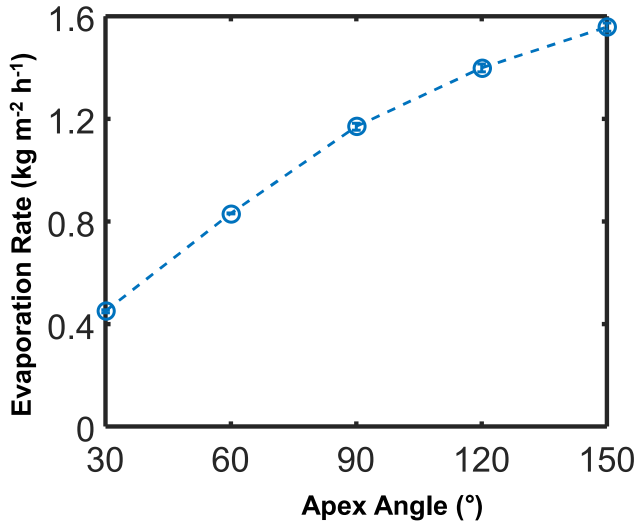


Figure S8. Water evaporation rate evaluated by using the true area of the carbon layer as the normalization factor for the BLV systems of different apex angles when under one-sun illumination.

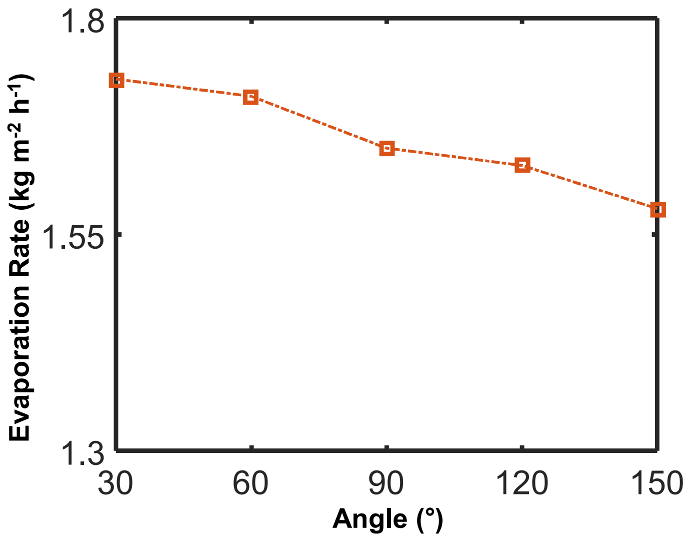


Figure S9. Water evaporation rate under one-sun illumination for the BLV systems of different apex angles when its height was varied but the carbon layer length was maintained at a constant value of 20 mm.

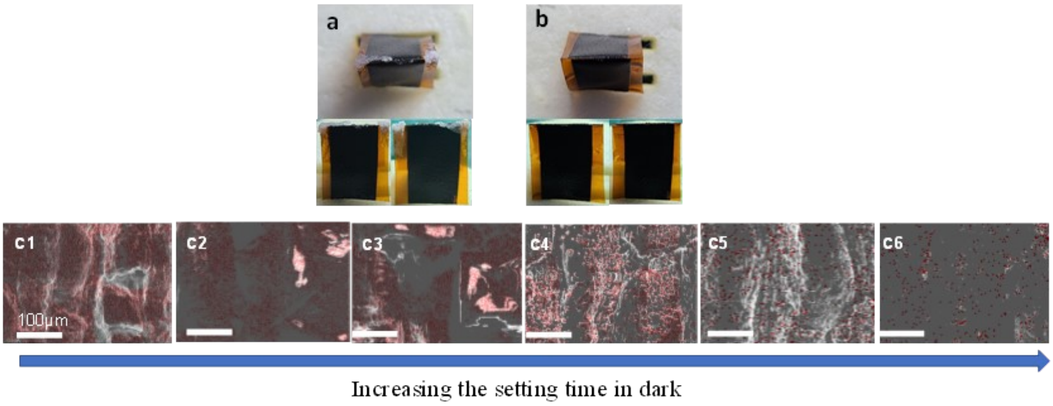


Figure S10. (a) Optical image of 30° BLV under 6hr one sun illumination (b) Optical image of (a) after 8hr setting in the dark. (c1) - (c6) EDS mapping image of BLV set in dark for 0h,1h,2h,4h,6h,8h (red color indicates solidum element).

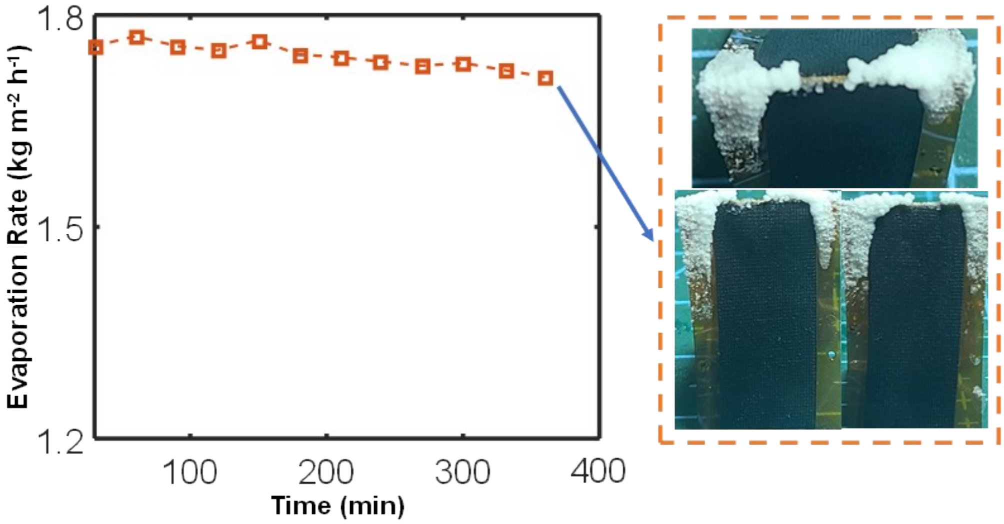


Figure S11. Effect of the operational time on the evaporation rate of a 30º BLV system under one sun illumination. The system was prepared by folding a hydrophilic carbon/PI bilayer film that is used for preparing the 120° BLV system with carbon layer length of 40 mm (Table S2) into 30°. The inset shows the optical images of the BLV system after 6hr evaporation operation, which indicates the salts are mostly accumulated in the ridge region of the light absorbing carbon layer.

Table S4 Comparison of the characteristics of the TLF and BLV interfacial solar drive water evaporation systems created by DLWc method

	Manufacturing and Assembling Capability	Water Evaporation Rate under One-Sun Illumination		Salt Resistance Performance	Long-term Durability
		1hr	1day		
TLF	Tri-layer film preparation involves a somewhat laborious manufacturing process, but the system assembly is easy	Excellent, as high as 93.2 %	Excellent, maintaining 95.7 % of the original rate	Good, minor salt accumulation at the edges of the system (both exterior edge and interior hole edge)	Excellent, no deterioration on the water evaporation rate during 6 months of test
BLV	Two-layer film manufacturing process is easy, but the system assembly is somewhat difficult	Good, as high as 89.0 %	Depending upon apex angle; 30^{o} system can maintain 97.9 % of the original rate	Fair/Good, apparent salt accumulation but mostly concentrated in the ridge region of the V-shape	Good, no deterioration on the water evaporation rate upon 30 cycles of on-off one sun illumination test