Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting Information

Ultra-robust carbon fibers for multi-media purification via solar-evaporation

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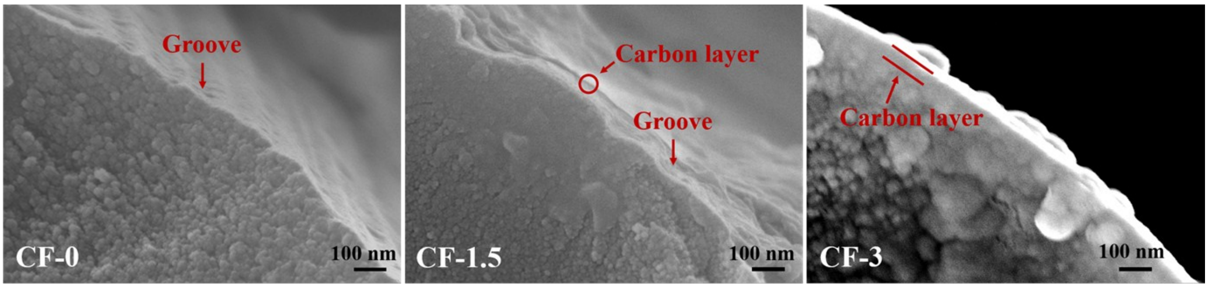

Figure S1. The cross-section morphology of original and modified CFs.

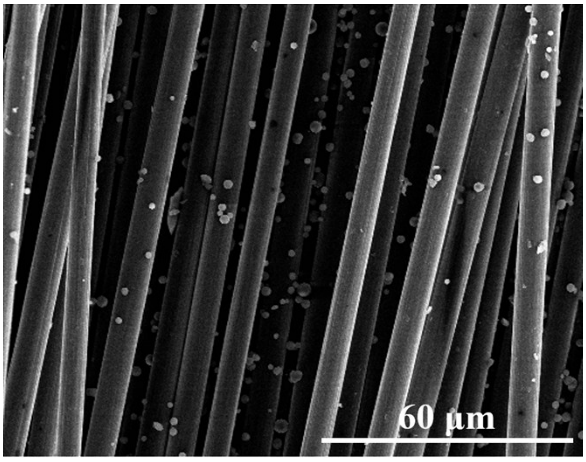

Figure S2. The surface morphology of modified CFs using glucose solution with concentration of 4.5 wt.%. Sphere-like nanoparticles grow on the fiber surface.

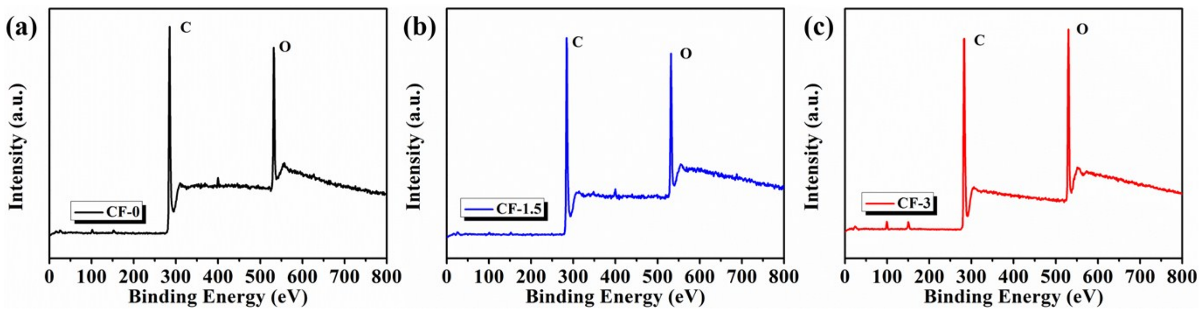

Figure S3. XPS wide scan spectra of (a) CF-0, (b) CF-1.5 and (c) CF-3.

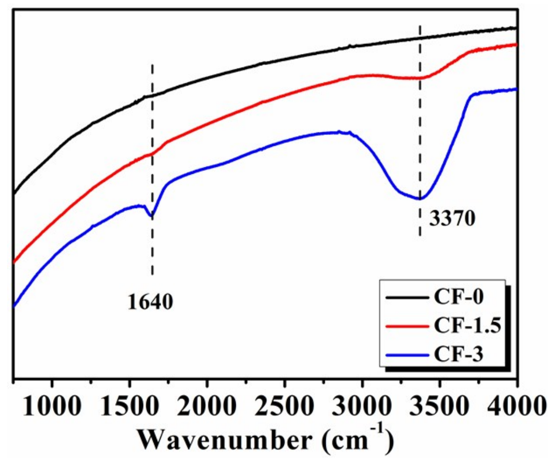

Figure S4. FT-IR spectra of CF-0, CF-1.5 and CF-3.

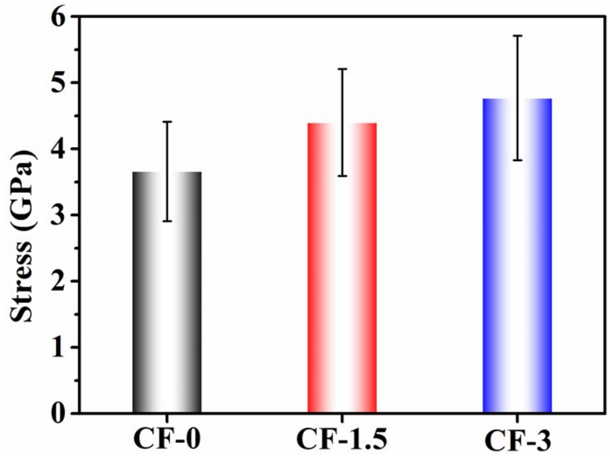

Figure S5. Single fiber tensile strength of CF-0, CF-1.5 and CF-3. Each sample was measured 25 times to calculate the average.

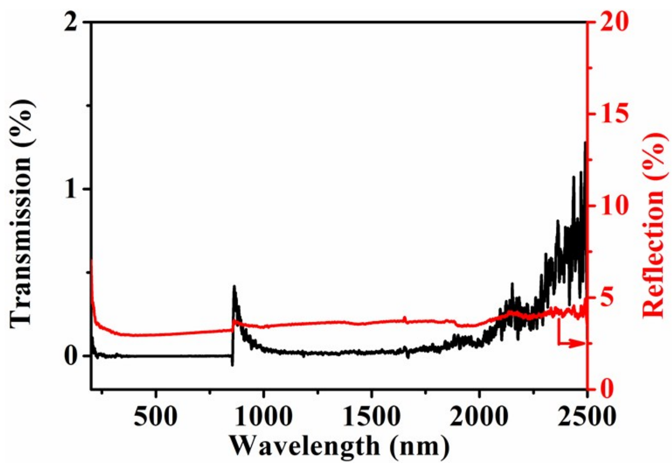

Figure S6. The transmission and reflection of CF-3 under wet state.

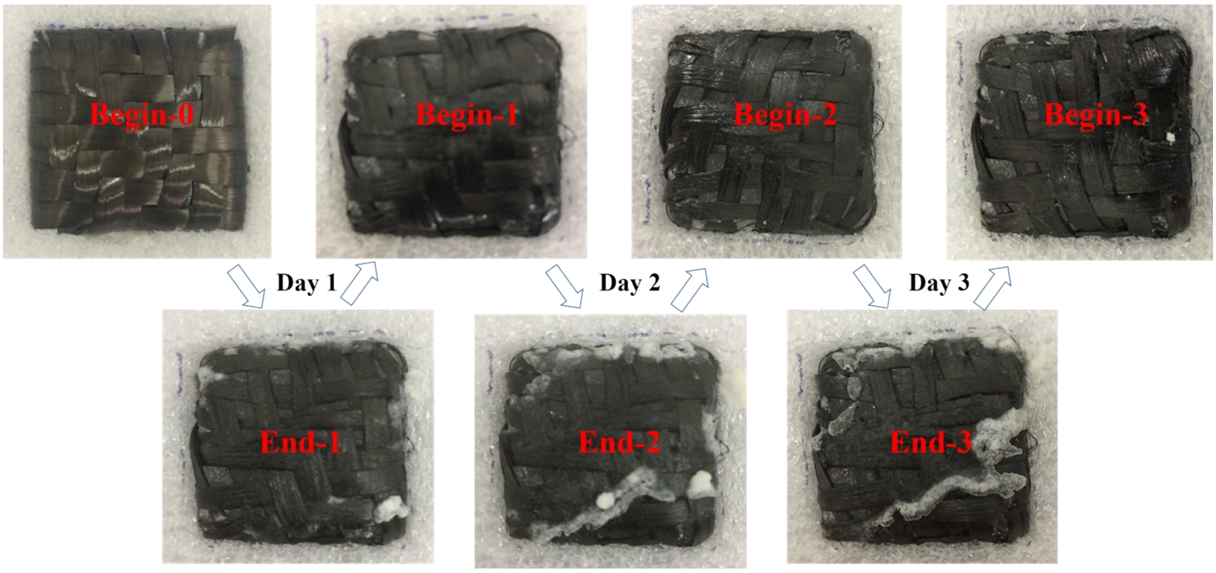

Figure S7. The salt precipitated on the surface of CFs fabrics on daytime illumination via solar-to-steam generation process and re-dissolved back to underlying water after one night rest and restore a clean surface using simulated Dead Sea as the feed. The excellent capillary endowed by the polar carbonized layer allows for the self-water pumping and good anti-salt fouling.

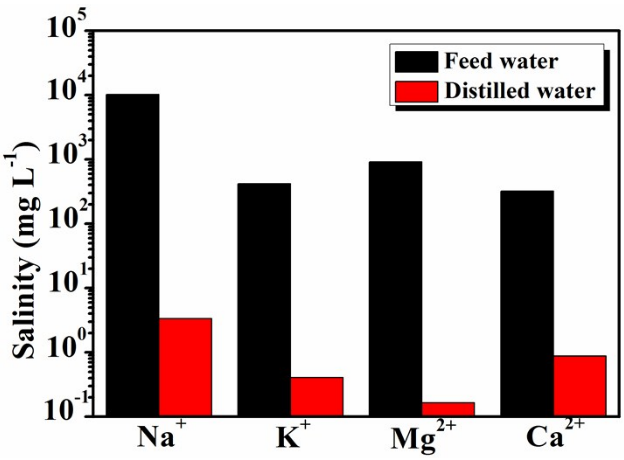

Figure S8. The concentrations of four primary ions in simulate sea water (3.5 wt.%) before and after solar thermal purification.

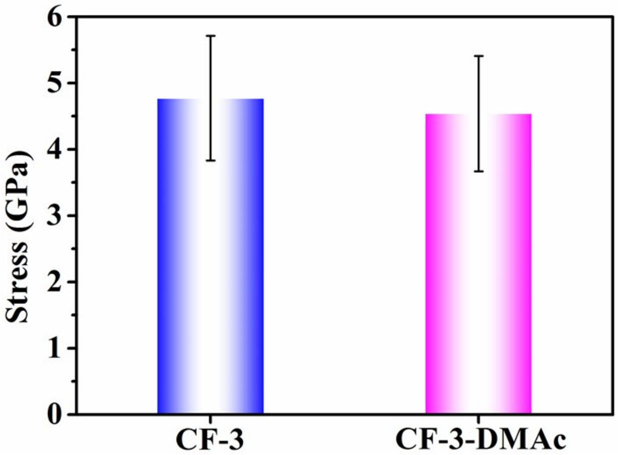

Figure S9. Single fiber tensile strength of CF-3 before and after immersing in DMAc solvent for ten days.

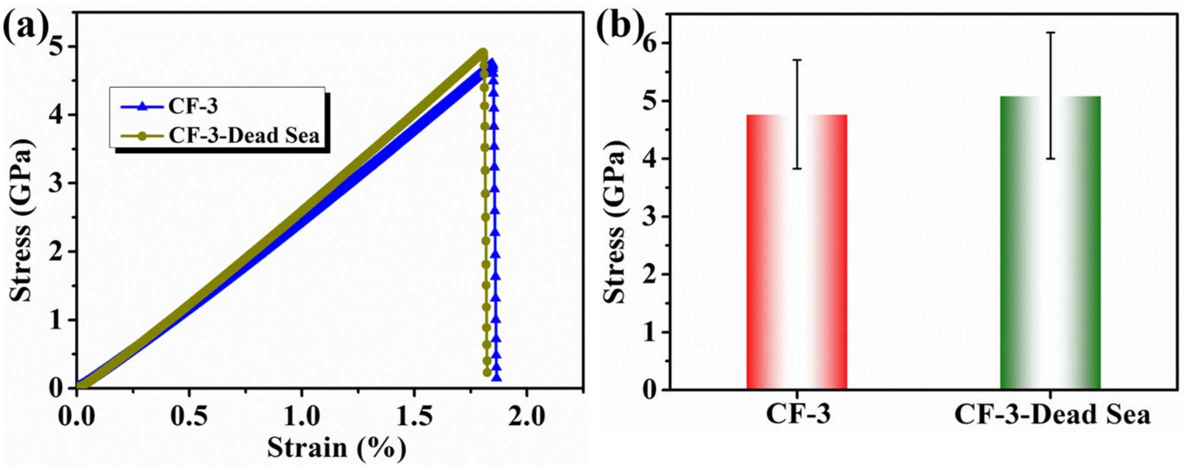

Figure S10. Single fiber tensile strength of CF-3 before and after immersing in high-concentration brines (10 wt.%) for ten days.

Table S1. The O/C atomic ratios on CF surface.

Sample	O (Atomic, %)	C (Atomic, %)	O/C
CF-0	17.26	76.89	0.22
CF-1.5	18.69	78.00	0.24
CF-3	21.67	75.82	0.29

Table S2. Carbon fiber contact angle and surface energy.

Sample	Contact Angle (°)		WORK surface energy ($mN\ m^{-1}$)		
	Water	Diiodomethane	γ^{p}	γ^{d}	γ^{T}
CF-0	86.2	37.8	1.60	40.70	42.30
CF-1.5	68.3	47.4	9.51	35.55	45.06
CF-3	55.1	58.2	19.85	29.61	49.46

The analysis of heat loss:

(1) Radiation:

The radiation heat loss was calculated according to Stefan-Boltzmann Equation S1.

$\Phi=\varepsilon A\sigma(T_1^4-T_2^4)$ (S1)

where Φ (W m^{-2}) is the radiation heat flux, A (m^2) is the surface area, σ is the Stefan-Boltzmann constant (5.67 × 10^{-8} W m^{-2} K^{-4}), ε is the emissivity of material supposed as the maximum emissivity of 1 in this paper, T_1 (310.15 K) is the surface temperature of CF-3 at steady state under 1 sun illumination, and T_2 (307.15 K) is the ambient temperature upward the material under 1 sun illumination. Therefore, according to equation (1), the radiation heat flux is 20 W m^{-2}, which is ~2% of the solar flux (1 sun = 1000 W m^{-2}).

(2) Convection:

The convection heat flux was calculated by Newton' law of cooling:

$Q= hA\Delta T$ (S2)

where Q (W m^{-2}) is the convection heat flux, h (10 W m^{-2} K^{-1}) is the convection heat transfer coefficient, and ΔT is the different value between the surface temperature and the ambient temperature upward the material under 1 sun illumination (ΔT=3 K). According to Equation S2, the convection heat flux is 30 W m^{-2}, which is ~3% of solar energy.

(3) Conduction:

The conduction heat flux was calculated according to the flowing Equation S3.

$Q=Cm\Delta T$ (S3)

where Q is heat loss, C is the specific heat capacity of water (4.2 J $^oC^{-1}$ g^{-1}), m (80 g) is the weight of water used in the paper, and ΔT (0.3 ^oC) is the temperature difference of pure water after and before solar illumination under 1 sun after 1 h. According mentioned above, the conduction heat loss was calculated ~30 W m^{-2}, which is ~3% of solar flux.