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.

<table>
<thead>
<tr>
<th>Sample</th>
<th>O (Atomic, %)</th>
<th>C (Atomic, %)</th>
<th>O/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF-0</td>
<td>17.26</td>
<td>76.89</td>
<td>0.22</td>
</tr>
<tr>
<td>CF-1.5</td>
<td>18.69</td>
<td>78.00</td>
<td>0.24</td>
</tr>
<tr>
<td>CF-3</td>
<td>21.67</td>
<td>75.82</td>
<td>0.29</td>
</tr>
</tbody>
</table>

Table S2. Carbon fiber contact angle and surface energy.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Contact Angle (°)</th>
<th>WORK surface energy (mN m⁻¹)</th>
<th>γ°</th>
<th>γd</th>
<th>γf</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water</td>
<td>Diiodomethane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CF-0</td>
<td>86.2</td>
<td>37.8</td>
<td>1.60</td>
<td>40.70</td>
<td>42.30</td>
</tr>
<tr>
<td>CF-1.5</td>
<td>68.3</td>
<td>47.4</td>
<td>9.51</td>
<td>35.55</td>
<td>45.06</td>
</tr>
<tr>
<td>CF-3</td>
<td>55.1</td>
<td>58.2</td>
<td>19.85</td>
<td>29.61</td>
<td>49.46</td>
</tr>
</tbody>
</table>
The analysis of heat loss:

(1) Radiation:

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

\[ \Phi = \varepsilon \sigma (T_1^4 - T_2^4) \quad (S1) \]

where \( \Phi \) (W m\(^{-2}\)) is the radiation heat flux, \( A \) (m\(^2\)) is the surface area, \( \sigma \) is the Stefan-Boltzmann constant \((5.67 \times 10^{-8}\) W m\(^{-2}\) K\(^{-4}\)), \( \varepsilon \) 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 \(\sim\)2% of the solar flux (1 sun = 1000 W m\(^{-2}\)).

(2) Convection:

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

\[ Q = hA\Delta T \quad (S2) \]

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

(3) Conduction:

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

\[ Q = Cm\Delta T \quad (S3) \]

where \( Q \) is heat loss, \( C \) is the specific heat capacity of water \((4.2\) J \(\circ\)C\(^{-1}\) g\(^{-1}\)), \( m \) (80 g) is the weight of water used in the paper, and \( \Delta T \) (0.3 \(\circ\)C) 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 \(\sim\)30 W m\(^{-2}\), which is \(\sim\)3% of solar flux.