Supporting Information

Gradient vertical-channels within aerogels based on N-doped graphene meshes toward efficient and salt-resistant solar evaporation

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Total number of pages (including cover page): 21
Total number of Figures: 14
Total number of Tables: 2
Figure S1. The photographs of ring-like (A) 3-N-RGO, (B) 5-N-RGO, and (C) 7-N-RGO hydrogels.
Figure S2. The SEM image of honeycomb-like 5-N-RGO fabricated with 0.5 mol·L⁻¹ NH₄OH.
Figure S3. The SEM image of 5-N-RGO with high magnification, with the arrows showing the N-RGO bridges between the neighboring rings.
Supplementary Note

Note S1. The calculation of porosity of ring-like 5-N-RGO.

The porosity ($P$) of our ring-like 5-N-RGO was calculated from the following equation S1:\textsuperscript{1}

$$P = \frac{V_a - m}{V_a} \times 100\% = (1 - \frac{\rho_a}{\rho_s}) \times 100\%$$

where $V_a$ is the apparent volume of cylindrical N-RGO aerogel; $m$ is the mass of N-RGO aerogel; $\rho_s$ is the skeletal density of the solid constituent in aerogel, which is about 2 g·cm\textsuperscript{-3};\textsuperscript{1,2} $\rho_a$ is the apparent density of N-RGO aerogel (0.24 g·cm\textsuperscript{-3}). Because the aerogel was weighted in air, the weight of air was automatically eliminated.
**Figure S4.** The Raman spectrum of pristine GO precursor with two broadening characteristic peaks at ~1352 and ~1595 cm⁻¹.
Figure S5. Full XPS spectrum of pristine GO.
Figure S6. UV-vis-NIR spectrum of ring-like 5-N-RGO aerogel.
Table S1. Comparison of the photothermal conversion efficiency

<table>
<thead>
<tr>
<th>Materials</th>
<th>Photothermal conversion efficiency (%)</th>
<th>Light intensity (kW·m⁻²)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual ring-like 5-N-RGO</td>
<td>74.8</td>
<td>2</td>
<td>This work</td>
</tr>
<tr>
<td>Honeycomb-like 5-N-RGO</td>
<td>49.3</td>
<td>2</td>
<td>This work</td>
</tr>
<tr>
<td>Oxygen plasma treated graphene</td>
<td>53.5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Wood/Graphene oxide</td>
<td>22.5</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Hierarchical graphene</td>
<td>69.2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Carbon nanofiber/Carbon nanotube</td>
<td>29.8</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Wood/Carbon nanotubes</td>
<td>67.0</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Activated carbon fiber cloth</td>
<td>73.3</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>

Data were given or calculated in the respective references.
Table S2. The thermal conductivity of ring-like N-RGO aerogels fabricated with different GO concentration

<table>
<thead>
<tr>
<th>Materials</th>
<th>Thermal conductivity (W·m⁻¹·K⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-N-RGO aerogel</td>
<td>0.29</td>
</tr>
<tr>
<td>5-N-RGO aerogel</td>
<td>0.26</td>
</tr>
<tr>
<td>7-N-RGO aerogel</td>
<td>0.28</td>
</tr>
</tbody>
</table>
Figure S7. The infrared images of ring-like (A) 3-N-RGO and (B) 7-N-RGO aerogels.
Figure S8. The contact angles of water on the top center of ring-like (A) 3-N-RGO and (B) 7-N-RGO aerogels.
Figure S9. The infrared image of ring-like 5-N-RGO aerogel during water evaporation. The white circles highlight the boundary lines of different parts.
Supplementary Note

Note S2. The calculation of net energy gained from environment.

The net energy ($E_s$) gained from environment can be estimated by the following equation S2:8–10

$$E_s = -A_{\text{top}} \cdot e \cdot \sigma \cdot (T_{\text{top}}^4 - T_s^4) - A_{\text{side}} \cdot e \cdot \sigma \cdot (T_{\text{side}}^4 - T_s^4) - A_{\text{top}} \cdot h \cdot (T_{\text{top}} - T_s) - A_{\text{side}} \cdot h \cdot (T_{\text{side}} - T_s)$$  \hspace{1cm} (2)

where $A_{\text{top}}$ is the top surface area, $T_{\text{top}}$ is the weighted average temperature of top surface, $A_{\text{side}}$ is the side wall surface area, $T_{\text{side}}$ is the average temperature of side surface, $T_s$ is the surrounding temperature, $e$ is emissivity of the graphene absorber, $\sigma$ is the Stefan–Boltzmann constant, and $h$ is the average convection heat transfer coefficient.

As illustrated in Figure S9, the exposed side surface has a lower temperature than that of surrounding, and thus can gain energy from the surrounding.\textsuperscript{8–10} This net energy of N-RGO evaporator gained from environment (21.10 mW, calculated from the above equation S2) could significantly improve the vapor generation of N-RGO aerogel.
Figure S10. The dependence of evaporation rate of ring-like 5-N-RGO aerogel on light-intensity.
Figure S11. The optical images of (A) salt-free surface of ring-like 5-N-RGO aerogel and (B) salt-blockage surface of conventional honeycomb-like aerogel. The black circles highlight the top surface of aerogels.
Figure S12. The SEM images of ring-like 5-N-RGO aerogels after immersing in (A) strong acidic solution, (B) strong alkaline solution, and (C) polar solution for 24 h.
Figure S13. The optical images of ring-like 5-N-RGO aerogels (A) before and (B) after strong water steaming for 2 h.
Figure S14. The compressive stress-strain curve of ring-like 5-N-RGO.
References


