Supplementary material

Carbon-based materials are excellent photothermal conversion candidates due to their ability to absorb solar radiation across a broad wavelength range, resulting in high light absorption. They are superior candidates for large-scale and practical applications because of their wider sources, richer reserves, and lower prices compared to metal nanoparticles and semiconductor materials (Itkis et al. 2006, Murakami et al. 2012). By comparing the evaporation mass changes of four common carbon-based materials (graphite, carbon nanotubes, GO, and rGO) for doping, rGO is selected as a photothermal conversion material. This selection is based on rGO's high strength, wide absorption range, and low thermal conductivity, which significantly enhance the mechanical strength and evaporation efficiency of hydrogels (Zhu et al. 2010). Therefore, rGO-doped hydrogels were selected for subsequent experiments.

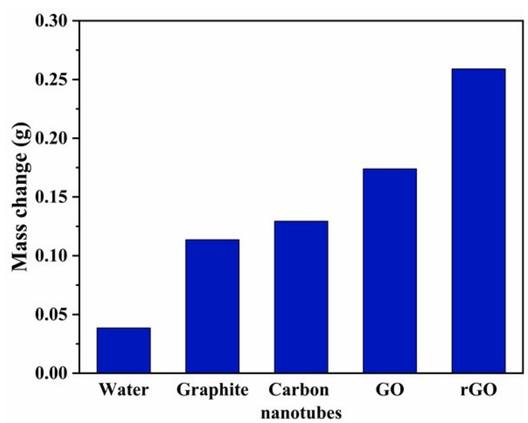

Fig. S1 Evaporation weight changes of pure water and hydrogels doped with four photothermal absorbers.

Since rGO is hydrophobic, the initial water contact angle is large when a water droplet falls on the hydrogel surface. However, the pore structure inside the hydrogel ensures that the water droplets are absorbed quickly and the water is constantly replenished during the evaporation process. The surface wettability analysis proved that the hydrogel has good hydrophilicity.

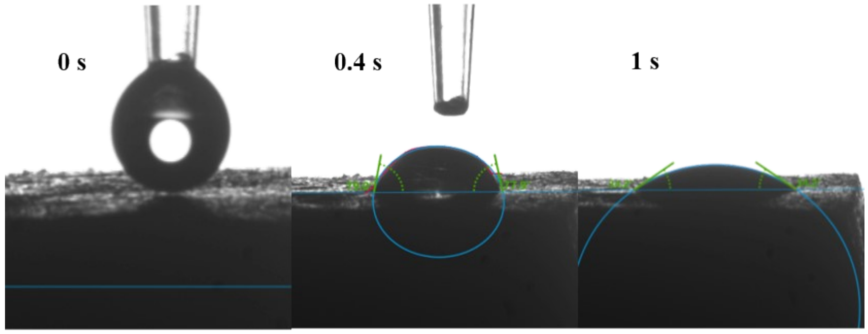

Fig. S2 Images of the water contact angle of a hydrogel.

The actual application of hydrogel in seawater desalination should be absorbed water saturation state, so the thermal conductivity is measured in the state of hydrogel absorbed full of water. The experiments were measured three times to take the average value to get the thermal conductivity of the hydrogel is 0.541 $W \cdot m^{-1} \cdot K^{-1}$, because about 92% of the hydrogel is water, the thermal conductivity of the water is 0.592 $W \cdot m^{-1} \cdot K^{-1}$. Therefore, the thermal conductivity of hydrogel is lower than the water. water, which is favorable to reduce energy loss during evaporation.

Tab. S1 Wet thermal conductivity of hydrogels.

Samples	Thermal conductivity（$W \cdot m^{-1} \cdot K^{-1}$）
1	0.540
2	0.542
3	0.540
average	0.541

To investigate the self-cleaning ability of the hydrogel, a simulated salt crystallization experiment was carried out in which 0.05 g NaCl was added to the surface of a 1 cm^2 hydrogel. The salt particles are mostly dissolved by the water molecules on the surface of the hydrogel in 10 min, almost completely dissolved in 30 min, and completely disappeared in 2 h (Fig. S2). Therefore, the hydrogel can accomplish self-cleaning in a relatively short time. This is largely due to the ability of the hydrogel's longitudinal channels to pump water from the bottom body of water to the surface of the hydrogel, as well as the microporous structure of the hydrogel that allows ions within it to move quickly to reduce salt concentrations. In conclusion, it is proved that the hydrogel has the ability of anti-fouling and self-cleaning, and even if there is salt deposition, it can dissolve the salt by itself.

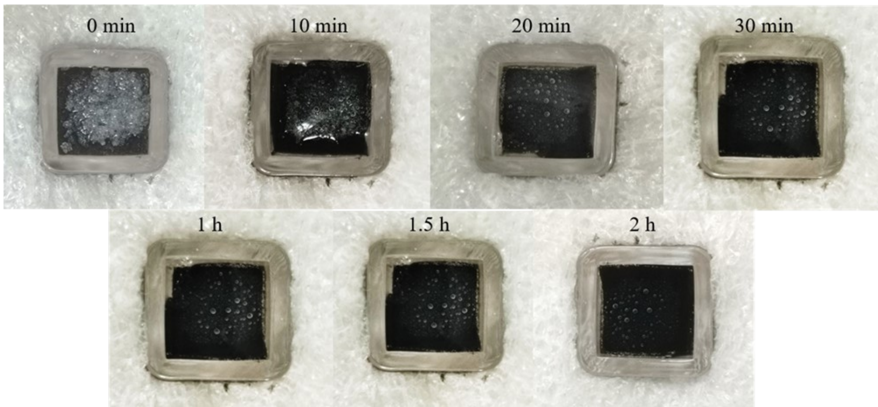

Fig. S3 Digital photographs of the hydrogel self-cleaning process.

References

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