Supplementary information for

Mechanically durable, sustained corrosion-resistant photothermal nanofiber membrane for highly efficient solar distillation

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Section 1 The energy consumption calculation.

The thermal-insulating reduced heat loss of the whole evaporation including 1) radiation loss P_{rad}, 2) convection loss P_{conv} and 3) conduction loss P_{cond}, detailed thermal loss analysis was performed as following calculations.

The radiation flux P_{rad} can be calculated by Stefan-Boltzmann law.

$$P_{rad} = \varepsilon\sigma\left(T_1^4 - T_2^4\right) \tag{1}$$

Where ε is the emissive rate (0.93), σ is the Stefan-Boltzmann constant (assumed to be 5.67×10^{-8} W (m^2 ▪ K^4) $^{-1}$), T_1 is the average temperature of the absorber (38.5 °C), and T_2 is the ambient temperature (36.4 °C, the vapor temperature). The top surface of the absorber is surrounded by heated vapor, which is very close to the temperature of membrane surface, the radiative and convective loss should be very small. As a result, the radiation heat flux is estimated to be 13.82 W/m^2, the radiation loss is about 1.4%.

The convection loss P_{conv} can be calculated by Newton's law of cooling.

$$P_{conv} = h\left(T_1 - T_2\right) \tag{2}$$

where P_{conv} denotes convection heat flux, h is the convection heat transfer coefficient (assumed to be 10 W (m^2 K) $^{-1}$). Here, the convection heat is estimated as ≈ 21 W/m^2, and the convection loss is about 2.1%.

The Conduction loss P_{cond} is based on Fourier's law.

$$P_{cond} = \frac{A'}{A} q_{water} \tag{3}$$

$$q_{water} = \kappa \frac{\Delta T}{\Delta L} \tag{4}$$

Where the A' is the direct contact area between water and membrane, the q_{water} is the heat flux transferred to water. With the occupation of water, the thermal conductivity κ

is closed to water (0.599 W/m·K^{-1}), the $\Delta T/\Delta L$ is approximate 100 K/m and A'/A was estimated to be 0.2. Thus, the conductive loss is about 5.99 W/m^2 and the heat loss rate is about 1.2%.

Table S1. The XPS elements compositions of the PI, PPy@PI and PDA/PEI/PPy@PI NFMs.

	PI membrane	PPy@PI membrane	PDA/PEI/PPy@PI membrane
C1s	60.65%	56.96%	52.64%
N1s	4.79%	13.85%	15.64%
O1s	34.56%	29.19%	31.72%

Table S2. The comparison of the substrates of the membrane-based evaporators on swelling problem in the reported in literatures.

Evaporator	Substrate	Water absorber	Whether there is a swelling problem (Yes or No)
RGO-paper[1, 2]	Airlaid paper	Airlaid paper	Yes
RGO–Fe_3O_4[3]	Airlaid paper	Airlaid paper	Yes
Carbonized wood[4]	Airlaid paper	Airlaid paper	Yes
RGO- film [5]	Cellulose filters	Cellulose filters	Yes
Carbon nano-particles[6]	Cellulose filters	Cellulose filters	Yes
GO [7, 8]	Filter paper	Filter paper	Yes
Au[9]	Filter paper	Filter paper	Yes
PPy-paper[10]	Wiping paper	Wiping paper	Yes
PDA[11]	Bacterial	Bacterial	Yes

	Nanocellulose	Nanocellulose	
Carbon nanotube[12]	Silicon/PEG	Silicon/PEG	Yes
PVDF[13]	PVA	PVA	Yes
Carbon nano-particles[14]	PVDF	PAN	Yes
RGO sheets[15]	Self-assemble	Glass-fibers	Yes
Ag/diatomite[16]	diatomite	Airlaid paper	Yes
Cu_2SnSe_3[17]	Fiber membrane	Nonwoven fabrics	Yes

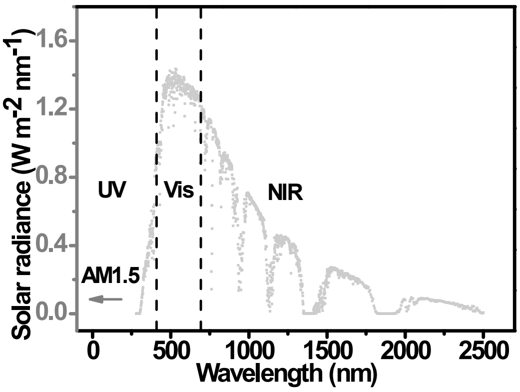

Figure S1. The solar spectral irradiance spectrum (AM 1.5 G).

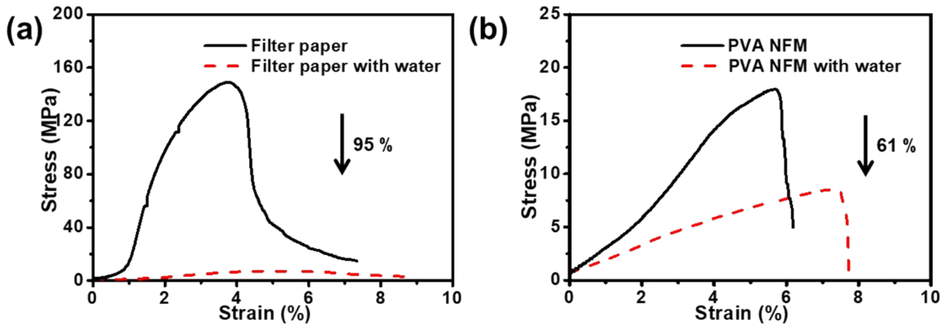

Fig. S2. (a) The tensile stress curves of filter paper at both dry and wet state. (b) The tensile stress curves of PVA NFM at both dry and wet state.

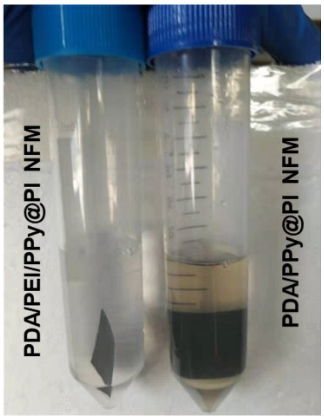

Fig. S3. The photographs of PDA/PPy@PI NFM and PDA/PEI/PPy@PI NFM immersion in alkali solution.

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