Supplementary Information (SI) for Nanoscale Horizons.

Microfluidic fiber-spinning chemistry for hydrophilic-hydrophobic Janus membranes towards efficient interfacial solar evaporation

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Supplementary figures

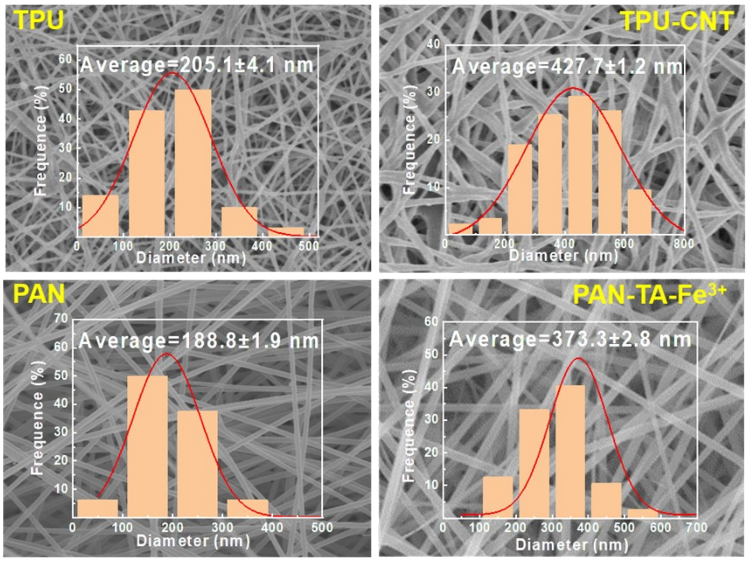

Figure S1. SEM images and size distributions of TPU, TPU-CNT, PAN and PAN-TA-Fe^{3+} fibrous membrane.

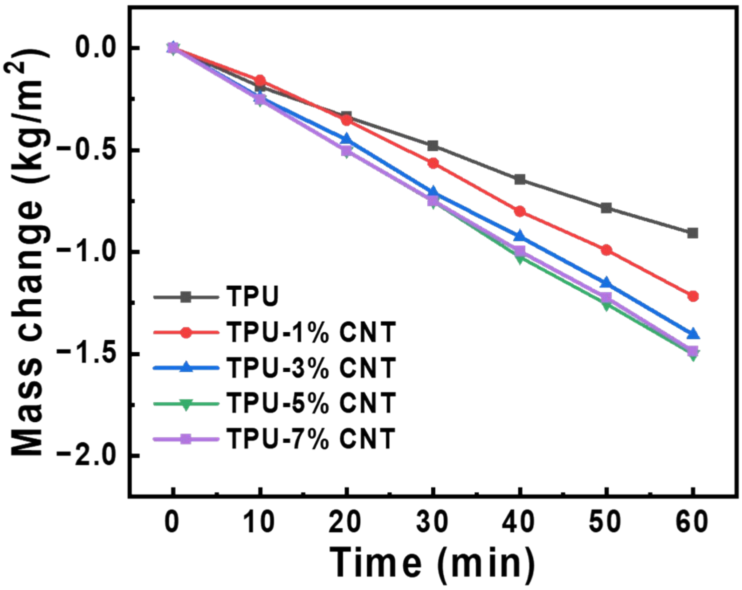

Figure S2. Water evaporation performance of TPU-CNT fibrous membrane with different CNT content.

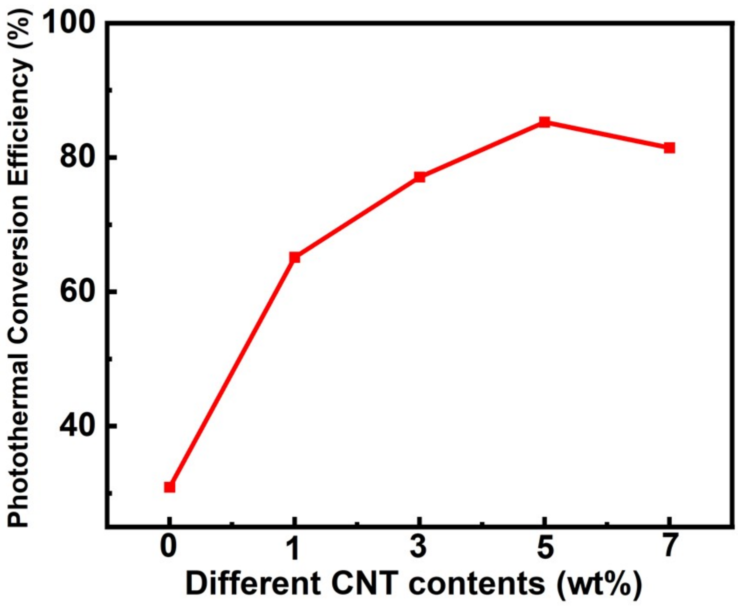

Figure S3. Photothermal conversion efficiency of PAN-TA-Fe^{3+}/TPU-CNT fibrous membrane with different CNT content.

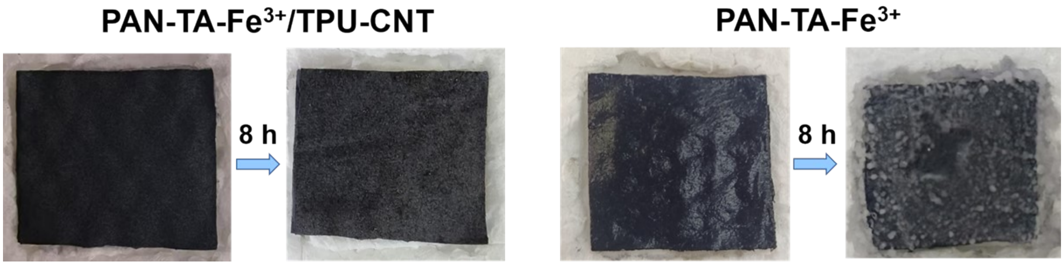

Figure S4. Optical photographs of PAN-TA-Fe^{3+} fibrous membrane before and after evaporation in 10 wt% NaCl for 8h.

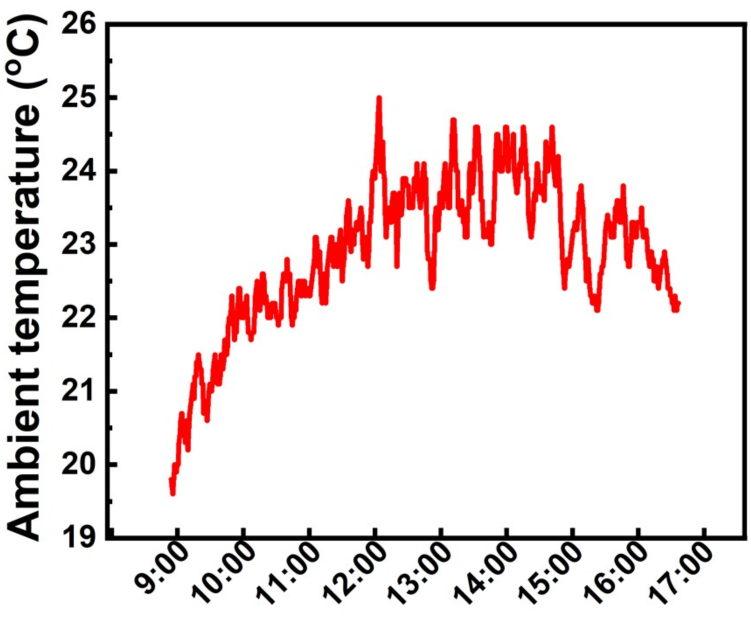

Figure S5. Ambient temperature during evaporation from 9:00 am to 17:00 pm.

Table S1. The structural properties of PAN-TA-Fe^{3+}, TPU-CNT membrane.

Sample	S_{BET} (m^2/g)	*pore size* (nm)	*Thickness* (μm)
PAN-TA-Fe^{3+}	22.906	56.62	102
TPU-CNT	2.4139	70.38	64

Calculation of Gas-Liquid Enthalpy of PAN-TA-Fe^{3+}/TPU-CNT

To determine the gas-liquid enthalpy of the Janus membrane (h_{LV}*), the following equation is used:

$$h_{LV}{*}=h_{lv}\ m_w/m{*} \quad \textbf{(3)}$$

The gas-liquid enthalpy of water (≈ 2260 J·g^{-1}), m_w is the evaporation rate of water in the dark field (≈ 0.128 kg·m^{-2}·h^{-1}), and $m*$ is the evaporation rate of the Janus membrane in the dark field (≈ 0.149 kg·m^{-2}·h^{-1}). Using this equation, $h_{LV}*$≈1941.47 J·g^{-1}.

Heat Loss Analysis of Interfacial Solar Evaporators

Heat loss in interfacial solar evaporators arises from (1) convection, (2) radiation, and (3) conduction. The calculations for each are as follows:

(1) Convection Heat Loss

Convection heat loss (P_{conv})is calculated using Newton's law of cooling:

$$P_{conv}=h_{conv}(T_2\text{-}T_1) \quad (4)$$

Here, h_{conv} is the convection heat transfer coefficient (5 W·m^{-2}·K^{-1}), T_2 is the temperature at the evaporation interface (315.9 K), and T_1 is the surrounding water vapor temperature (309.2 K). Using this equation, P_{conv}≈33.5 W·m^{-2}, accounting for approximately 3.35% of the total irradiation energy.

(2) Radiation Heat Loss

Radiation heat loss (P_{rad}) occurs when the Janus membrane radiates heat to the air and depends on surface and environmental temperatures. It is calculated using Stefan Boltzmann's law:

$$P_{rad}=\varepsilon\sigma(T_2^4\text{-}T_1^4) \quad (5)$$

Here, σ is the Stefan-Boltzmann constant (5.67 × 10^{-8} W·m^{-2}·K^{-4}), ε is the optical absorption of the Janus membrane (92.5%), T_2 is the temperature at the evaporation interface (315.9 K), and T_1 is the surrounding water vapor temperature (309.2 K). Thus, under one-sun conditions, P_{rad} is approximately 42.92 kW·cm^{-2}, accounting for 4.29% of the total solar energy.

(3) Conduction Heat Loss

The use of thick insulating foam minimizes heat loss to bulk water. The conduction heat loss experiment was divided into three parts: the top absorbing layer, the middle insulating layer, and the bottom water layer. A foam material with extremely low thermal conductivity was used for the insulating layer. Its thickness and low conductivity ensured that heat conduction losses during the experiment were negligible.