Supporting Information

Ferric tannate photothermal material for efficient water distillation

Cheng Zhang,† Zhaowei Chen,† Zijing Xia, Ruben Z. Waldman, Hao-Cheng Yang, Shao-Lin Wu, and Seth B. Darling**

Experimental

Synthesis of ferric tannate

Tannic acid and iron chloride were both bought from Sigma-Aldrich (USA), and used as received. A solution of 40.0 mg·mL^{-1} tannic acid was made by dissolving tannic acid powder in RO water. An aqueous solution of 6.0 mg·mL^{-1} iron chloride was prepared by dissolving iron chloride in RO water. In a 100 mL beaker with vigorous magnetic stirring, 40.0 mL RO water and 400.0 μL tannic acid were added. Then, the iron chloride was added in steps of 10% volume of the target amount every 10 seconds. The mixture was kept stirring for 10 minutes.

Fabrication of photothermal coating

Polyvinylidene fluoride (PVDF) membranes were purchased from Millipore Sigma (USA). The diameter of the membrane is 48 mm, and the average pore size is 0.22 μm. The membranes are hydrophilic because they were blended with hydrophilic modifier during fabrication. Titanium tetrachloride (TTC), the precursor for TiO_2 ALD, was obtained from Sigma-Aldrich (USA). A general fabrication process is described as follows. The ferric tannate particles were filtrated onto a PVDF membrane by a Sand core filtration device. After drying in the air, the samples were transferred to an ALD reactor for TiO_2 deposition (**Scheme 1**). ALD was conducted in a hot-walled, viscous flow reactor constructed by a circular stainless-steel tube with an internal diameter of 5 cm. All the experiments were performed at 100 °C using ultrahigh purity (99.999%) nitrogen carrier gas. The dose times of TTC and water were both 5 s, and the purge times were 30 s and 40 s, respectively. The ALD cycle number was 30 for the

membranes. The membrane was cut into a round of 30 mm to ensure the entire surface was covered by the photothermal coating.

Characterization

The microstructural observation of ferric tannate particles was performed on a transmission electron microscope (TEM, JEOL). The surface morphologies and element distribution of the coatings were characterized by field emission scanning electron microscopy (FE-SEM, Hitachi). The infrared images were taken by an FTIL C2 Compact Thermal Imager. Both solution and solid UV-Vis-NIR absorption and reflection spectra were detected by a UV-Vis-NIR spectrometer (Lambda 950, PerkinElmer). Particle size distribution in ferric tannate solution was detected by a particle size analyzer (Zetasizer Nano, Malvern), and the surface wettability was evaluated by a contact angle test system (FM40, KRÜSS). All the solar evaporation tests were conducted under a solar simulator (Oriel 300 W, Newport).

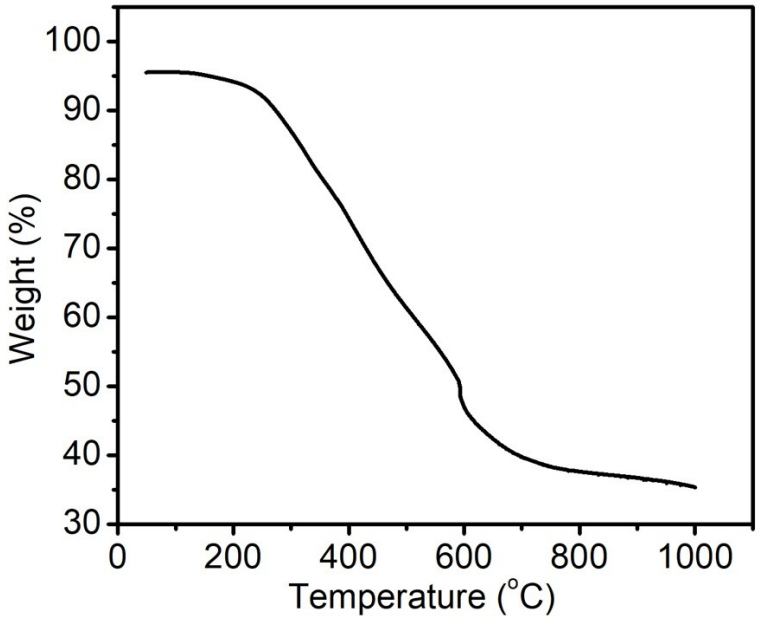

Figure S1 Thermogravimetric analysis of TA-Fe^{3+} complex.

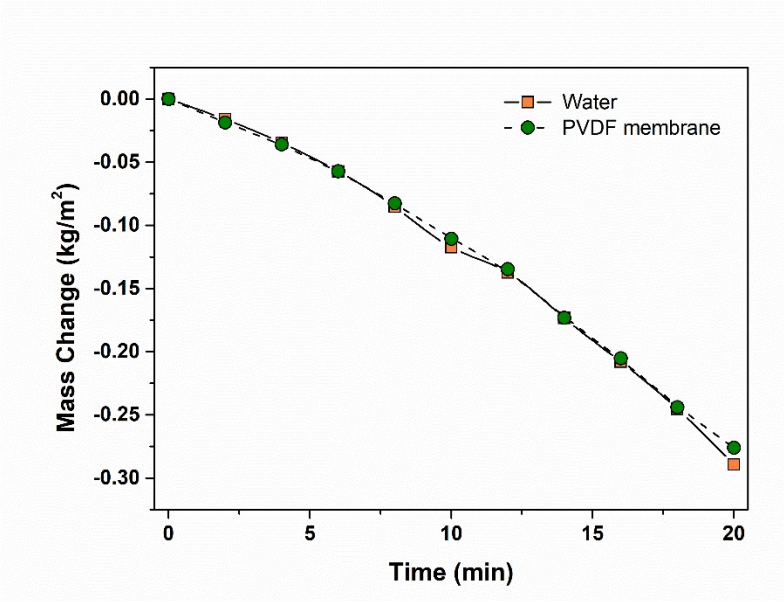

Figure S2 The reference group of nascent PVDF membrane. The result indicates that PVDF has little contribution to the photothermal performance of ALD/ferric tannate membrane.