Supporting information

Efficient solar steam generation of carbon black incorporated hypercrosslinked polymers composites

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Characterizations

The FTIR was recorded from in the range of 4000-400 cm^{-1} using the KBr pellet technique on a Nexus 670 spectrum instrument. XPS spectra was obtained using a PHI-5300 ESCA spectrometer (Perkin–Elmer). The morphologies were observed by scanning electron microscope (SEM, JSM-6701F, JEOL, Ltd.). The optical adsorption spectra was measured by UV-vis-NIR spectrometer equipped with an integrating sphere (PerkinElmer Lambda 900) in the range of 200-2500 nm. The thermal conductivity was evaluated using flash method thermal analyzer (LFA 447, Netzsch). The water contact angles were measured by using a contact angle meter (DSA100, Kruss). The specific surface area and porosity of the as prepared samples were measured by N_2 adsorption and desorption at 77.3 k using a volumetric sorption analyzer (micromeritics ASAP 2020).The solar steam generation experiments were conducted by a lab-made online testing system consisted by a solar simulator (xenon arc lamp, CEL-S500, Ceaulight) equipped with a solar filter (AM 1.5, Ceaulight), an infrared camera (Testo 869, Germany), an electronic balance (FA2004, 0.1 mg in accuracy) and an optical power meter (CEL-NP2000-2, Beijing Education Au-light Co., Ltd.). The ion concentrations of the purified water were measured by atomic absorption spectrometer (ContrAA700 Jena Germany).

Calculation of the energy conversion efficiency

The evaporation rate is calculated from the slope of the time-dependent mass change curves, the solar steam efficiency (η) is given by

$$\eta = mh_{Lv}/C_{opt}\, q_i$$

where η is solar steam efficiency, m is the mass flux of steam (the rate of water evaporation under the dark environment subtracted), C_{opt} is the optical concentration, q_i is the nominal direct solar irradiation 1 kW m^{-2}, h_{Lv} denotes total enthalpy of liquid-vapor phase change (including sensible heat and phase-change enthalpy), can be calculated as

$$h_{Lv} = \lambda + C\Delta T$$

where λ is the phase change enthalpy of water from liquid to steam (the latent heat varies from 2430 kJ/kg at 30 °C to 2256 kJ/kg at 100 °C), C is specific heat capacity of water (4.2 kJ kg^{-1} K^{-1}), ΔT denotes the temperature increase of the water.

The water contact angle of C-[BzMim]Cl-co-PhH and C-[BzPy]Br-co-PhH.

As shown in Figure S1, when water droplets were dropped on the top surface of the C-[BzMim]Cl-co-PhH and C-[BzPy]Br-co-PhH the water droplets could be absorbed by the sample immediately, the C-[BzMim]Cl-co-PhH and C-[BzPy]Br-co-PhH exhibits a water contact angle about 0°, indicating the hydrophilic property of the C-[BzMim]Cl-co-PhH and C-[BzPy]Br-co-PhH.

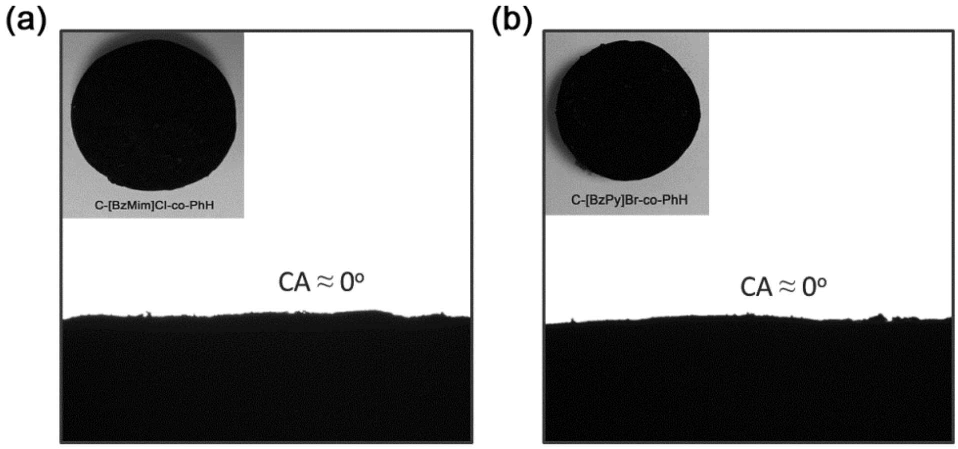

Figure S1. (a) The water contact angle of C-[BzMim]Cl-co-PhH. (b) The water contact angle of C-[BzPy]Br-co-PhH.

The salt-resistance performance of the C-[BzMim]Cl-co-PhH and C-[BzPy]Br-co-PhH

A concentrated brine solution (with a salinity of 5, 10 and15 wt%) was used to confirm the salt-resistance performance of the C-[BzMim]Cl-co-PhH and C-[BzPy]Br-co-PhH under 1 sun illumination. The time-dependent mass changes of concentrated brine solution (with a salinity of 5, 10 and15 wt%) are shown in Figure S2a-b, and the evaporation rates are obtained from the slope of the time-dependent mass change curves. As shown in Figure S2c-d, with a salinity of 5, 10 and 15 wt%

under 1 sun illumination, the evaporation rates of C-[BzMim]Cl-co-PhH were calculated to be 1.25, 1.21 and 1.19 kg m^{-2} h^{-1} and for C-[BzPy]Br-co-PhH these values are 1.35, 1.32 and 1.29 kg m^{-2} h^{-1}, respectively. The evaporation rates slightly decrease with the increase of salinity, indicating the HCPs composites possess excellent salt-resistance in solar steam generation. These results could be owed to porous structure and interconnected water channels, thus leading the pumped water replenish the surface vaporized water and avoid salt accumulation.

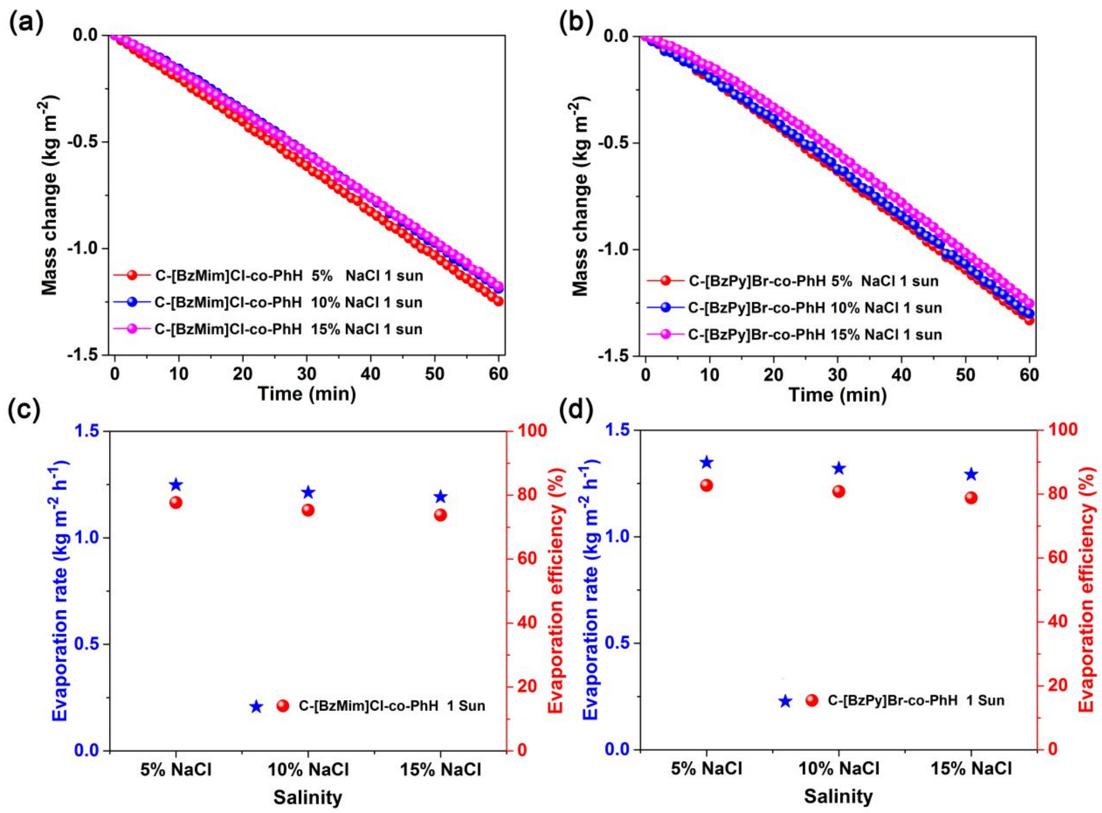

Figure S2. (a, b) Time-dependent mass changes of concentrated brine solution (with a salinity of 5, 10 and15 wt%) under 1 sun illumination. (c, d) Evaporation rate and evaporation efficiency of concentrated brine solution (with a salinity of 5, 10 and15 wt%) under 1 sun illumination.