ADVANCED ENERGY MATERIALS

Supporting Information

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Superwetting Monolithic Hollow-Carbon-Nanotubes Aerogels with Hierarchically Nanoporous Structure for Efficient Solar Steam Generation

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Porosity measurement of the CMPs-based carbon aerogels (CMPCAs). Round CMPCAs with 15 mm in diameter and 10 mm in thickness was firstly weighted and the weight was defined as W_i. Subsequently, the sample was immersed in 20 mL ethanol. The ethanol saturated CMPCAs was measured and the weight was W_f. The porosity of the CMPCAs was measured by using equation: $Porosity(\%)=(W_f-W_i)/\rho*V_i$

Where ρ is the density (0.789 g/cm^3) of the ethanol and V_i is the volume of the CMPCAs.

Superhydrophilic treatment of the CMPs aerogels. The CMPCAs were firstly cut into a wafer with 10 mm in height and 32 mm in diameter by using a knife. Subsequently, the CMPCAs was immersed into 20 mL of ammonium peroxydisulfate saturated 1M H_2SO_4 for 24 h under stirring at room temperature. After that, the CMPCAs was washed by the ultrapure water and ethanol for several times, respectively, to remove the residual acid and ammonium peroxydisulfate. Finally, the CMPCAs was dried at 75 ^oC for 12 h to obtain a constant weight.

Solar steam generation test. The solar steam generation experiments was conducted at a lab-made, online, real-time measurement system which is composed by a solar light simulator (xenon arc lamp, CEL-S500, Ceaulight) with a solar filter (AM 1.5, Ceaulight), a test chamber with 80 mm in height 34 mm in diameter, (3) an analytical balance (FA 2004) (4) a computer to record the time-dependent mass change of water due to the stream generation (5) an infrared camera (Testo 869, Germany). Light intensity was measured by a full spectrum optical power meter (CEL-NP2000-2, Beijing Education Au-light Co., Ltd.). During each test, the room temperature was maintained at 21-23 ^oC and the humidity was ranged from 30 and 35%.

Characterization

The morphology of the CMPCAs was taken on Scanning electron microscope (SEM JSM-6701F) and Transmission electron microscope (TEM Tecnai G2TF20). The specific surface area and porosity of the as-prepared CMPCAs was measured by N_2 adsorption and desorption at 77.3 k using a volumetric sorption analyzer (micromeritics ASAP 2020). Before analysis, the samples were degassed at 120 ^oC for 12 h under vacuum. The elemental analyse was carried out on an elemental analyzer (Elementar Vario EL). Thermogravimetric analyse was measured by thermogravimeter analyzer (Perkin Elmer) from room temperature to 800 ^oC at a heating and cooling rate of 10 ^oC min^{-1} under nitrogen atmosphere. The X-ray diffraction (XRD) was performed on a Rigaku D/Max-2400 diffractometer with 2 θ at 2° to 80°. The thermal conductivity of CMPCAs was investigated on flash method thermal analyzer (LFA 447, Netzsch). The UV-VIS-NIR absorption was conducted at UV-VIS-NIR spectrometer (JASCO V-670) from 200~2500 nm with an integrated sphere. The camera photos was recorded at PhotronFastcamMini UX100 type high speed video camera.

Calculation of the energy conversion efficiency

$\eta=m\ h_{Lv}/C_{opt}q_i$

where m is the mass flux of steam(the rate of water evaporation under the dark environmentis 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 latent heat of phase change (The latent heat varies from 2430 kJ/kg at 30 °C to 2265 kJ/kg at 100 °C), C is specific heat capacity of water (4.2 kJ kg^{-1} K^{-1}), and ΔT denotes the temperature increase of the water.

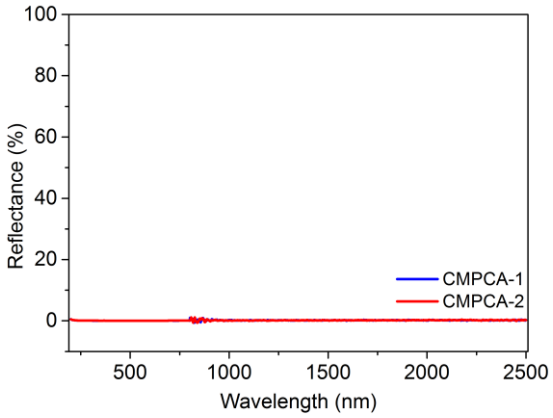

Figure S1 UV-vis-NIR reflectance spectra of the CMPCAs.