Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Electronic Supplementary Information

Conductive hollow kapok fibers-PPy monolithic aerogels with excellent mechanical robustness for efficient solar steam generation

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Porosity measurement of the kapok fibers-bsed aerogels. Round kapok fibers-based aerogels with 20 mm in diameter and 28 mm in height was firstly weighted and the weight was defined as W_i. Subsequently, the sample was immersed in 20 mL ethanol. The ethanol saturated aerogels was measured and the weight was W_f. The porosity of the aerogels 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 aerogels.

Characterization

The structure of the kapok fibers-based aerogels was investigated by Fourier transform infrared spectroscopy (FTIR Nicolet Nexus 670 FT-IR). The morphology of the kapok fibers-based aerogels was taken on Scanning electron microscope (SEM JSM-6701F) 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. Thermal conductivity of the kapok fibers-based aerogels was conducted by using a DRE-III thermal conductivity tester (Xiangtan Xiangyi instrument CO., LTD.). Before analysis, the sample was cut into a round with 3.2 cm in diameter and 2 cm in height and the sensor was sandwiched between the two samples. The compressive properties were performed by using an electrical universal material testing machine with equipped two flat-surface compression stages and a 500 N load cell (EZ-Test, SHIMADZU) at a stress rate of 5mm/min. The optical properties of the kapok fibers-based aerogels were conducted by ultraviolet–visible–nearinfrared spectrophotometer equipped with an integrating sphere (Lambda 900 UV/VIS/NIR PerkinElmer)

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 and 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 steam 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 19-22 ^oC and the humidity was ranged from 15 and 20%. The kapok fibers-based aerogels were cut into 5 mm in height to conduct the solar steam generation experiment.

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}, hLv 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.

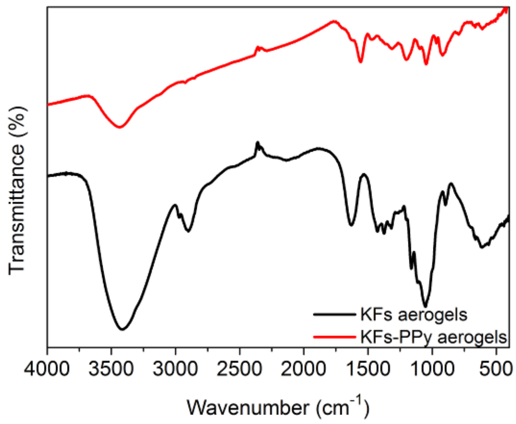

Figure S1 FTIR of the Kapok fibers-based aerogels

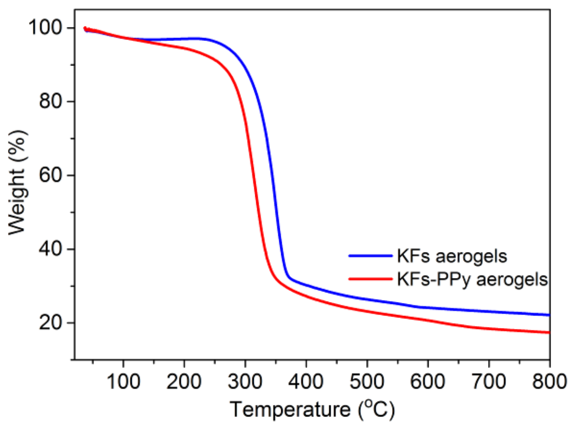

Figure S2 TGA curves of the Kapok fibers-based aerogels

The height has significant impact on the evaporation performance of the obtained kapok fibers-PPy aerogels. To confirm the influence of the height of the kapok fibers-PPy aerogels on the water evaporation performance, we prepared three kapok fibers-PPy aerogels with height of 0.5 cm, 1 cm and 2 cm to test the solar steam generation experiment under 1 sun (1000 W m^{-2}) illumination and the results are shown in Figure S3a-S3f. As shown in Figure S3d-S3f, with the increasing the height of the kapok fibers-PPy aerogels, the corresponding evaporation rates are increased and the evaporation rate was calculated to be 1.3752 kg m^{-2} h^{-1} for the kapok fibers-PPy aerogels with height of 0.5 cm, 1.5084 kg m^{-2} h^{-1} for the kapok fibers-PPy aerogels with height of 1 cm and 1.5798 kg m^{-2} h^{-1} for the kapok fibers-PPy aerogels with height of 2 cm respectively. The influence of the height on the evaporation rates of the kapok fibers-PPy aerogels may be attributed to the enhanced heat-insulation performance of the materials with the increasing of the height.

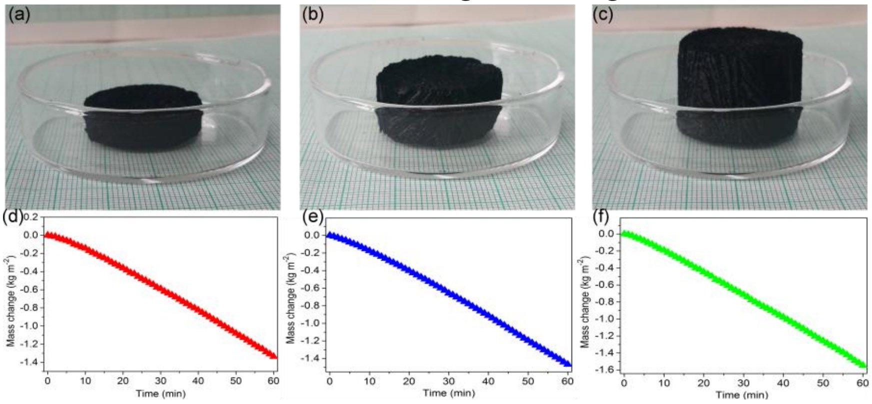

Figure S3 (a) Optical photo of the kapok fibers-PPy aerogels with height of 0.5cm, (b) Optical photo of the kapok fibers-PPy aerogels with height of 1 cm, (c) Optical photo of the kapok fibers-PPy aerogels with height of 2 cm, (d) Time-dependent mass change of the kapok fibers-PPy aerogels with height of 0.5 cm, (e) Time-dependent mass change of the kapok fibers-PPy aerogels with height of 1 cm, (f) Time-dependent mass change of the kapok fibers-PPy aerogels with height of 2 cm.