Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary materials

Cheap, Facile, and Upscalable Activated Carbon-based Photothermal Layers for Solar Steam Generation

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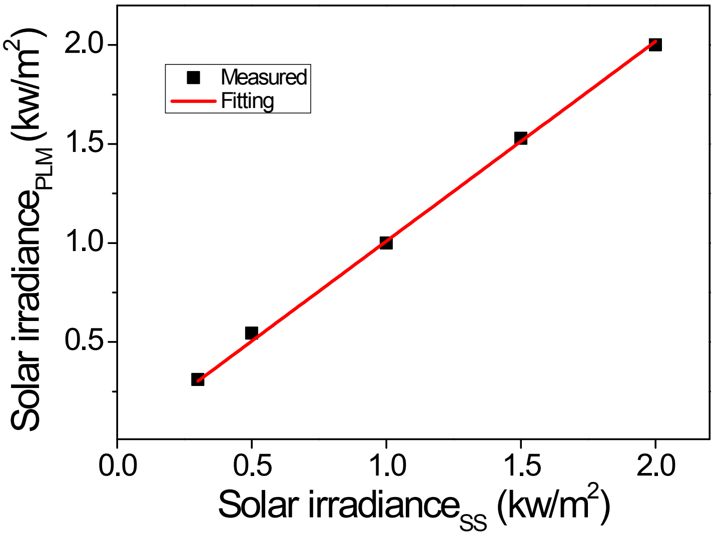

Figure S1. Plot of solar irradiation measured by portable light meter versus solar irradiation provided by solar simulator calibrated with photovoltaic reference cell.

Table S1. BET surface area, mean pore size, pore volume and ranges of particle size of the three commercial activated carbons.

	BET surface area (m^2/g)	Mean pore size (nm)	Pore volume (cm^3/g)	Ranges of particle size (µm)
DUKSAN	987.49	2.21	0.5457	6-30
CEP21KS	1722.90	2.28	0.9818	7-9
YP50F	1747.00	1.89	0.8270	8-10

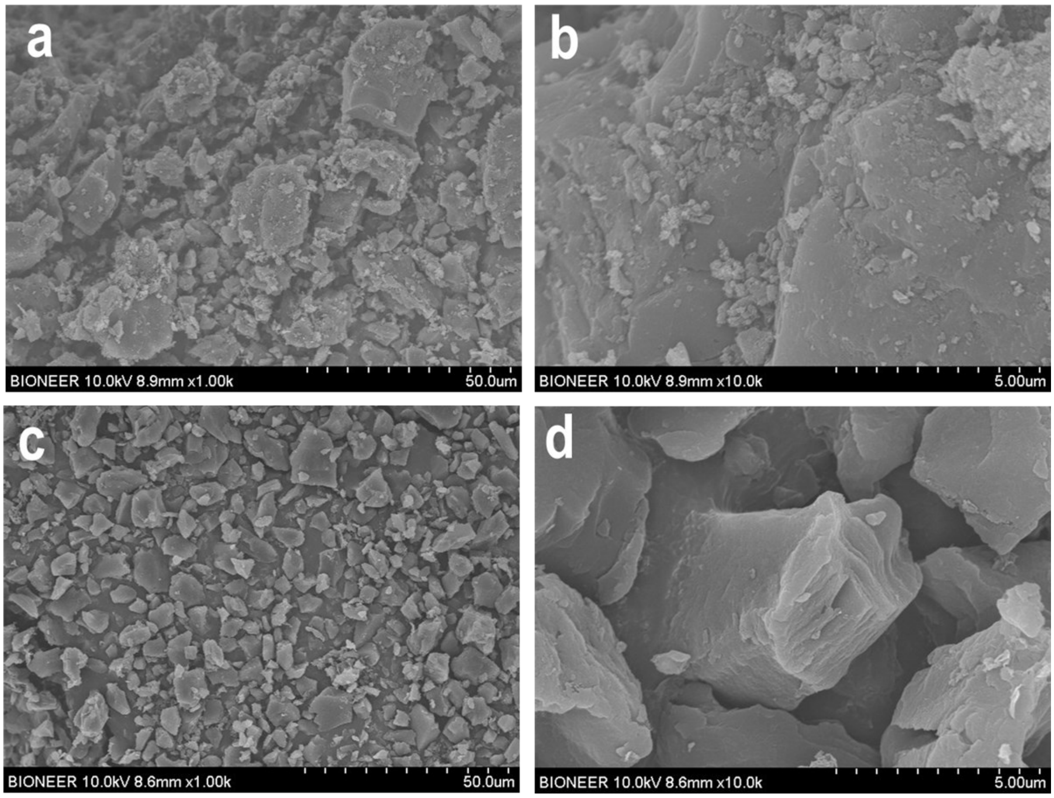

Figure S2. SEM images of (a,b) ACLA-D, (c,d) ACLA-Y samples (top view).

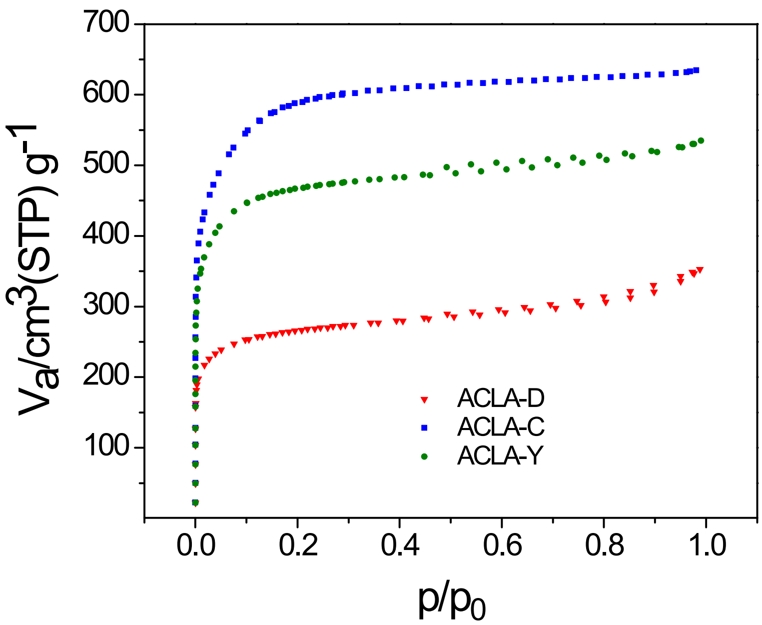

Figure S3. N_2 adsorption-desorption patterns of the commercial activated carbon samples.

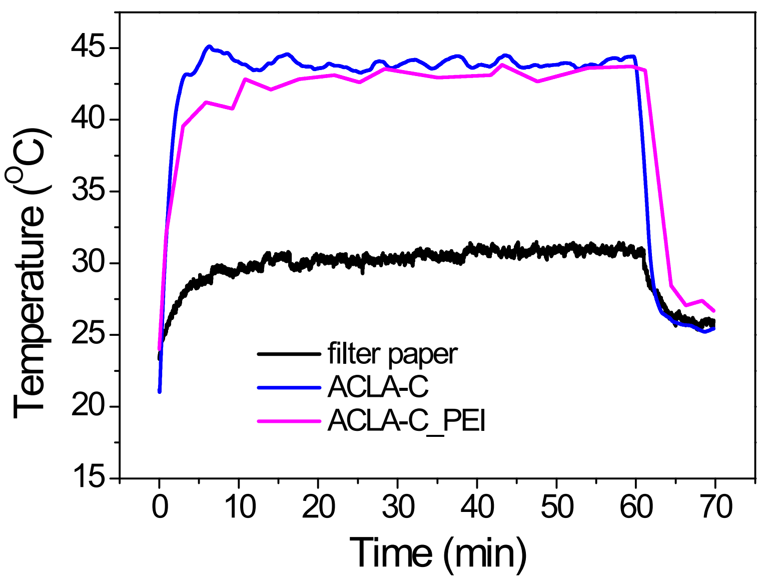

Figure S4. Surface temperature profiles of the bare filter paper, ACLA-C and ACLA-C_PEI in wet condition monitored during solar-to-steam generation under 1 sun irradiance.

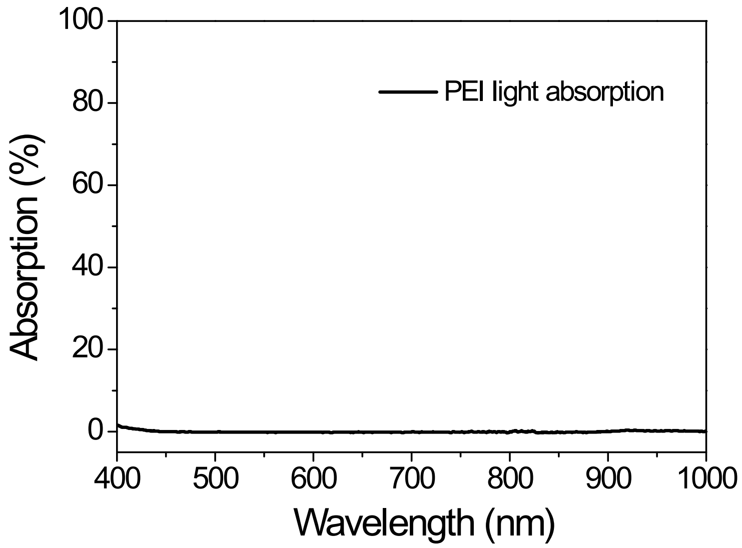

Figure S5. Light absorption of PEI.

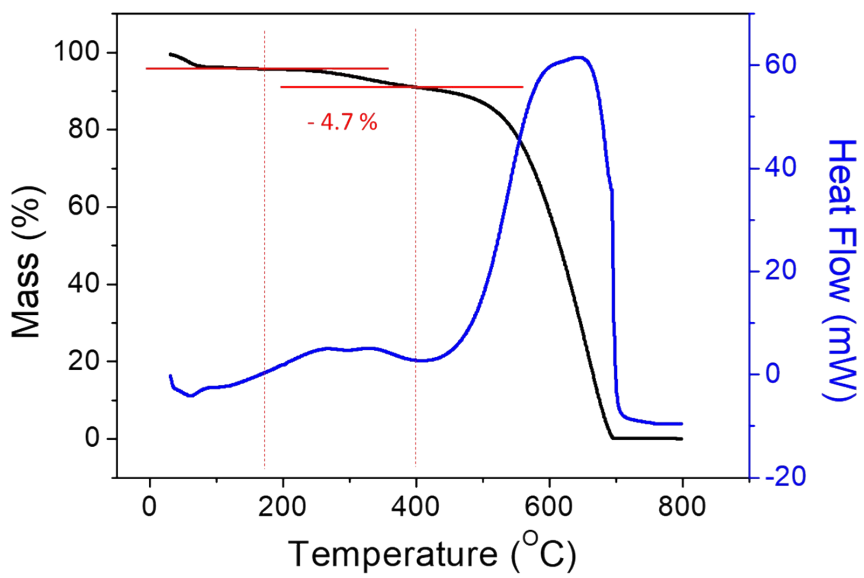

Figure S6. TGA-DSC analysis of PEI-treated AC-C.

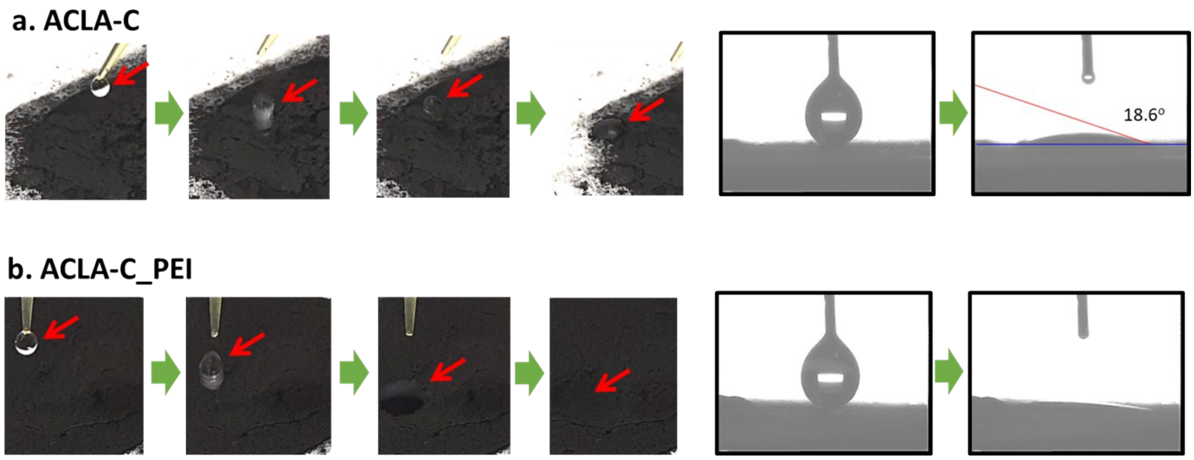

Figure S7. a) The snapshots of the movie (Movie S1) showing a water droplet repelled from the surface of dry ACLA-C and the contact angle measurement of wet ACLA-C. b) The snapshots of the movie (Movie S2) showing a water droplet spreading and soaking on the surface of dry ACLA-C_PEI and the contact angle measurement (not measurable).

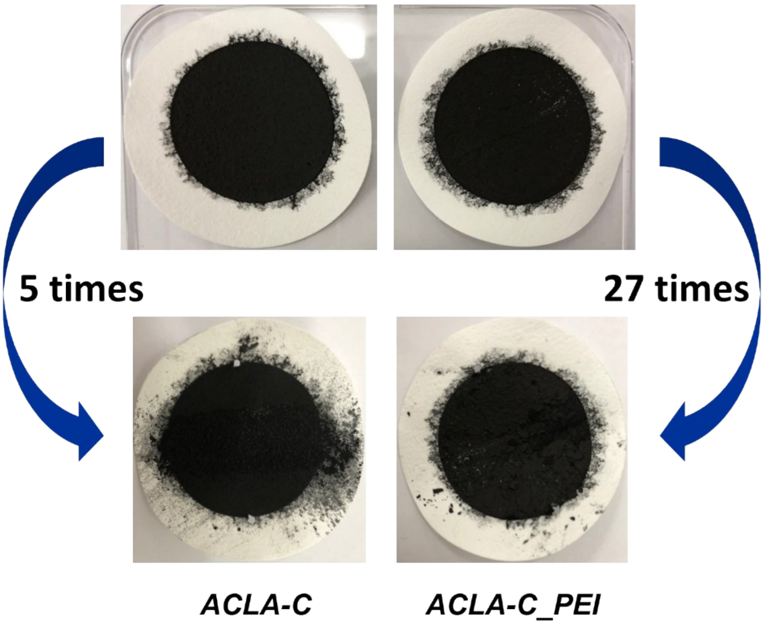

Figure S8. (a) Schematic diagram of bending test, (b) before and after bending test images of ACLA-C and ACLA-C_PEI, taken over 50 times of bending. Bending test was performed with dry samples of ACLA-C and ACLA-C_PEI. The ACLA photothermal layer showed very poor adhesion properties and detachment of AC powders were observed only after 5 times of bending test. On the other hand, the robustness of ACLA-C_PEI photothermal layer could be maintained up to 27 times of bending in the same conditions.

Table S2. Summary of steam generation rate under 1 and 3 sun irradiance (unit: kg/m^2h).

	1sun	3sun
Bulk water	0.35±0.01	0.86±0.02
Filter paper	0.86±0.01	1.67±0.01
ACLA-D	1.09±0.02	3.00±0.02
ACLA-C	1.17±0.01	3.48±0.04
ACLA-C_PEI	1.24±0.01	3.83±0.01
ACLA-Y	1.11±0.03	3.13±0.02

The calculation of photo-thermal conversion efficiency

The photo-thermal energy conversion efficiency (η) is calculated by using the following equation:

$$\eta = \dot{m} h_{LV} / I$$

Here the $\dot{m}$ is the evaporation rate of water under steady-state conditions (kg/m^2h) at specific temperature and atmospheric pressure, h_{LV} represents the total enthalpy of liquid to vapor phase change process, and I is the power density of solar irradiation (1,000 W/m^2) used in the experiments. h_{LV} is the sum of two enthalpies and can be calculated as follows:

$$h_{LV} = \Delta h_{vap} + C_p \Delta T$$

Δh_{vap} is the latent heat of vaporization of water under standard atmospheric pressure, C_p is the specific heat capacity of water (4.2 kJ/kg K), and ΔT is the change of water temperature. Δh_{vap} is dependent on the temperature and can be obtained from a specific database (https://www.engineeringtoolbox.com/water-properties-d_1573.html). Under 1 sun irradiation the ACLA-C_PEI photo-thermal conversion efficiency was calculated to be 85.66%.