Supporting Information

Amorphous red phosphorus incorporated with pyrolyzed bacterial cellulose as free-standing electrode for lithium ion batteries

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Table S1 Component and related parameters of the equivalent circuit for the prepared electrodes, respectively.

electrode	Re(Ω)	Rct(Ω)	CPEi(F)	σω(Ω $s^{-0.5}$)	DLi+($cm^2\ s^{-1}$)
P-PBC-50	2.381	87.55	2.723×10^{-5}	62.14	2.83×10^{-14}
P-PBC-60	2.4	302.8	1.208×10^{-5}	149.98	4.86×10^{-15}
P-PBC-70	2.761	679	1.852×10^{-5}	797.35	6.32×10^{-16}
P-PBC-80	4.662	2077	1.367×10^{-5}	1822.25	3.30×10^{-17}

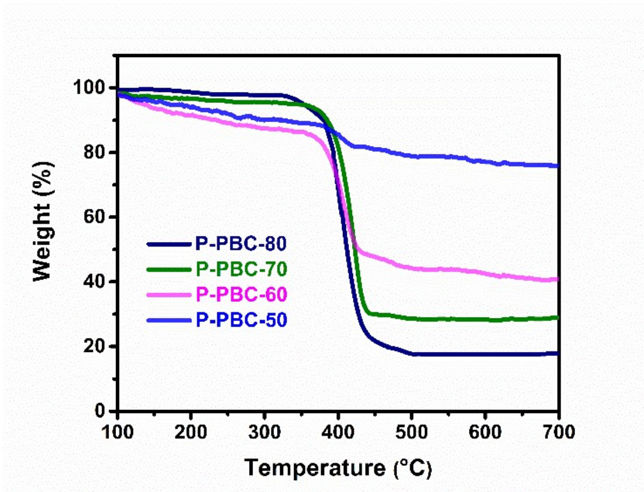

Fig. S1 TG curves of P-PBC composites. The slight weight loss at ~ 200 °C is possibly caused by desorption of the absorbed gases, such as CO, CO_2, and H_2O. Subsequent weight loss at 400 °C is related to the sublimation of red-P.

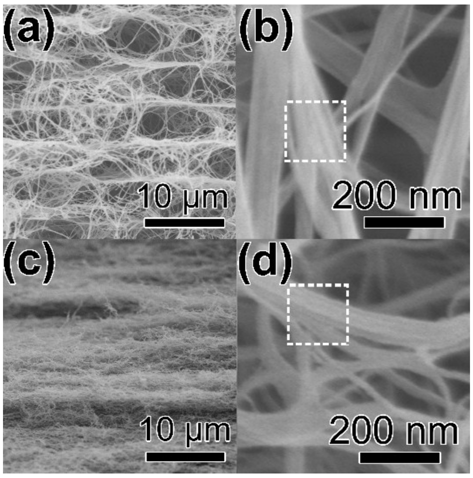

Fig. S2 a, c) SEM image of BC aerogel and PBC aerogel; b, d) corresponding high-magnification SEM image.

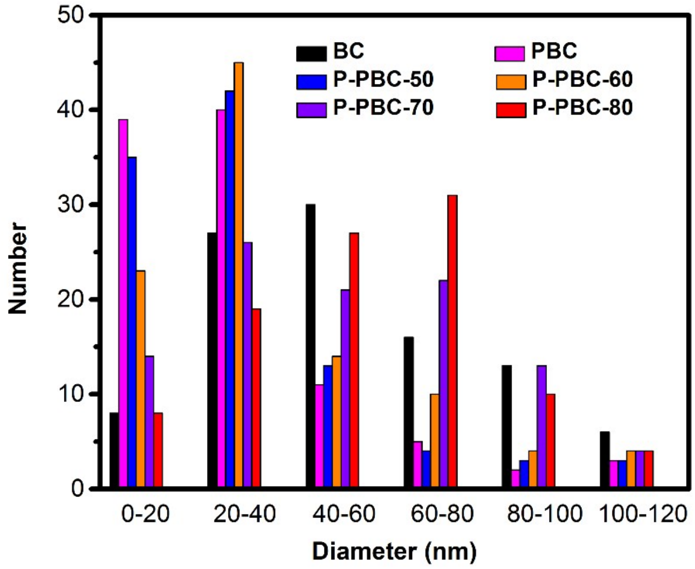

Fig. S3 The diameter distribution chart of BC aerogel, PBC aerogel, P-PBC electrodes. In total, 100 nanofibers were analysed (N=100) to generate nanofiber numbers of N as a function of nanofiber diameter. Where the diameters are obtained by measuring the nanofibers in SEM images.

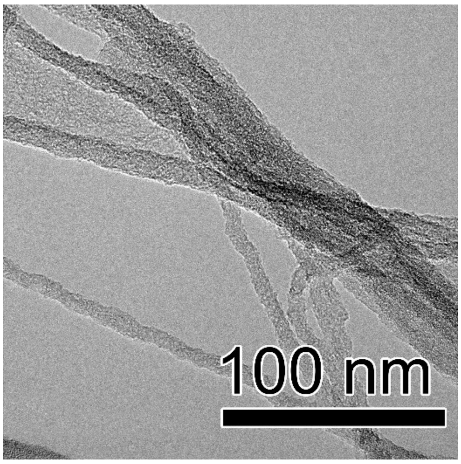

Fig. S4 TEM image of PBC aerogel

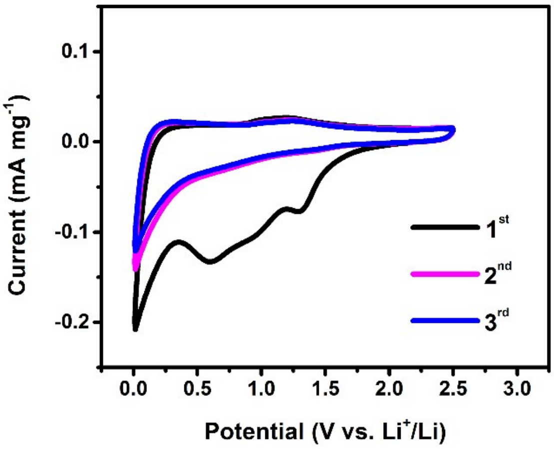

Fig. S5 CV curves of PBC film at the scan rate 0.2 mV s^{-1} in the first three cycles.

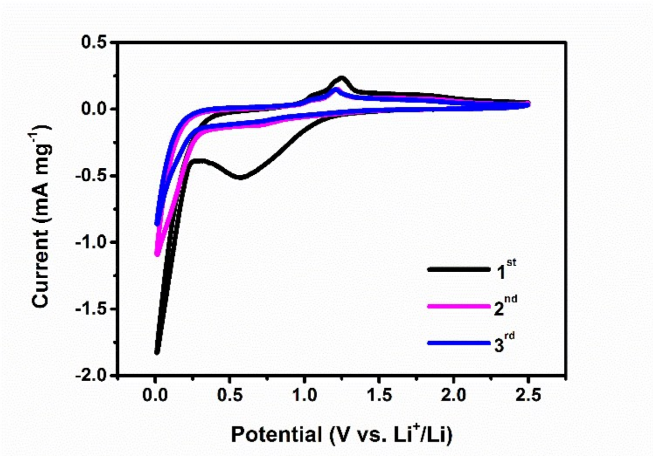

Fig. S6 CV curves of red-P at the scan rate 0.2 mV s^{-1} in the first three cycles.

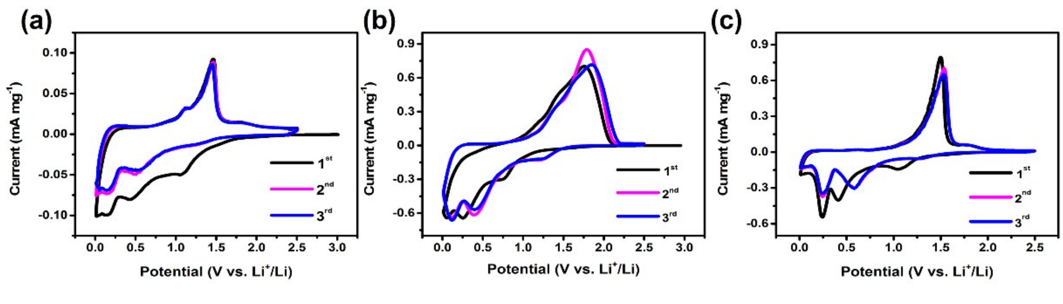

Fig. S7 CV curves of P-PBC-50, P-PBC-60 and P-PBC-80 at the scan rate of 0.2 mV s^{-1} in the first three cycles.

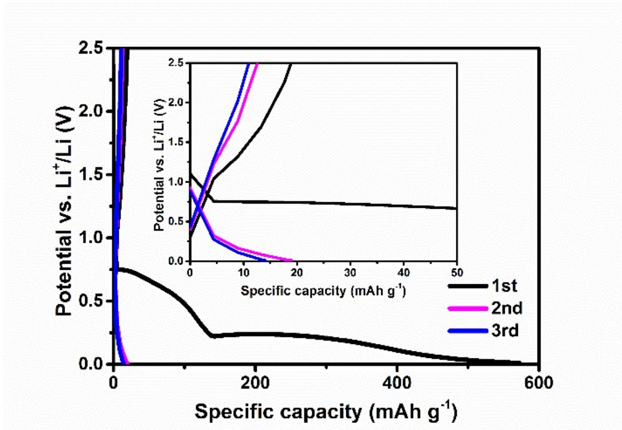

Fig. S8 Charge–discharge profiles of red-P at 260 mA g^{-1} in the first three cycles.

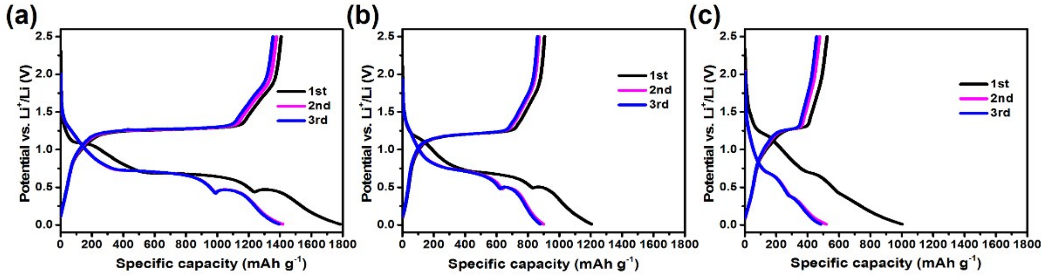

Fig. S9 First three cycles charge–discharge profiles of P-PBC-80, P-PBC-60 and P-PBC-50 electrodes at 0.1 C.

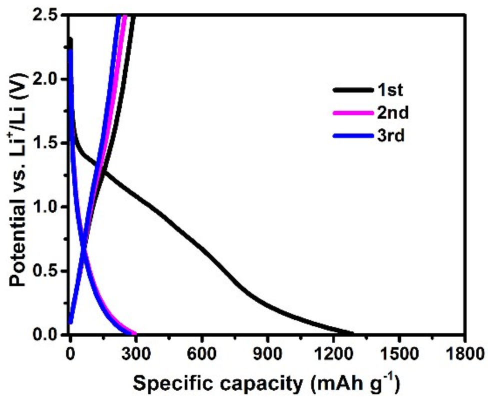

Fig. S10 Charge–discharge profiles of PBC film at 260 mA g^{-1} in the first three cycles.

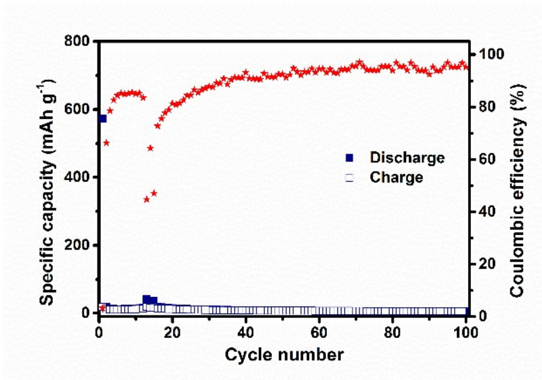

Fig. S11 Cycling stability test for red-P at 260 mA g^{-1} for 100 cycles.

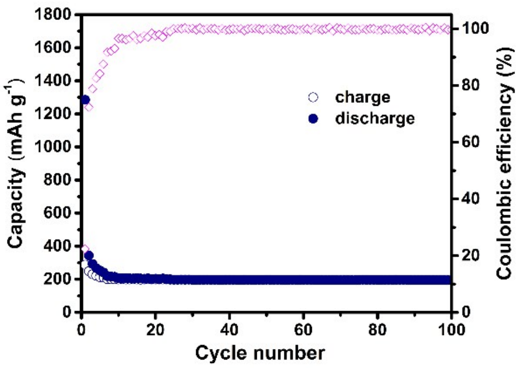

Fig. S12 Cycling stability test for PBC film at 260 mA g^{-1} for 100 cycles.

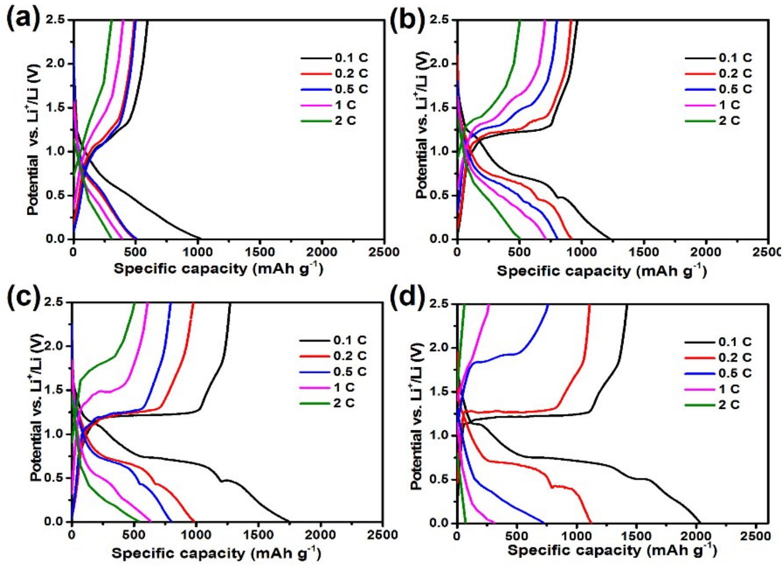

Fig. S13 Typical discharge–charge profiles at different rates of P-PBC-50, P-PBC-60, P-PBC-70 and P-PBC-80.

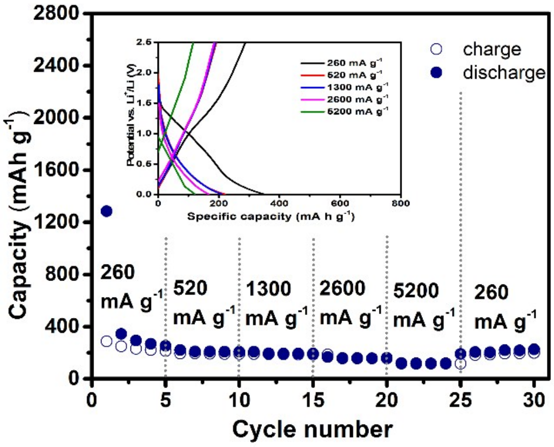

Fig. S14 Rate capability of P-PBC films from 260 to 5200 mA g^{-1} (inset: typical charge–discharge profiles at different current densities of PBC).

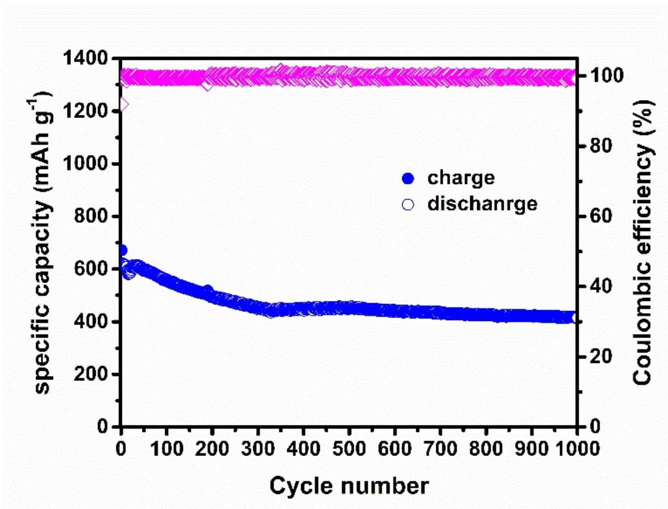

Fig. S15 Cycling stability of P-PBC-70 electrode at the high current density of 2 C for 1000 cycles.

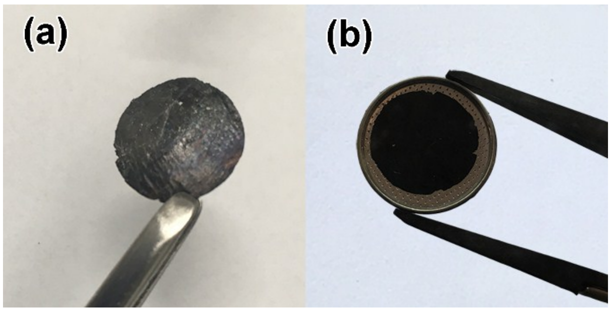

Fig. S16 Digital photograph P-PBC-70 electrode before and after 1000 cycles at 2 C.

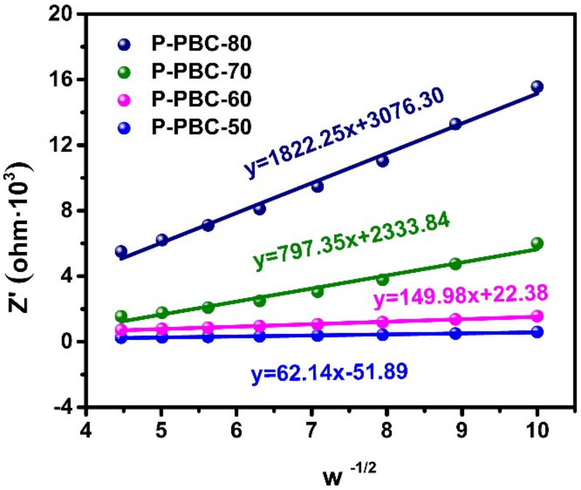

Fig. S17 Randles plots of P-PBC-50, P-PBC-60, P-PBC-70 and P-PBC-80 films at the charged state after 100 cycles at 0.1 C by applying an AC voltage of 5 mV amplitude over the frequency range from 100 kHz to 0.01 Hz. The Li^+ diffusion coefficient can be calculated from the formula as the follow:

$$D_{Li^+} = R^2T^2 / (2A^2n^4F^4C^2\sigma_\omega{}^2)$$

in which D_{Li^+} is the diffusion coefficient, R is the gas constant, T is the absolute temperature, A is the surface area of the electrode based on the coin cell, n is the number of the electrons per molecule attending the electrochemical redox reaction, F is the Faraday constant, C is the concentration of Li^+, and the value of Warburg coefficient σω is the slope of the line fitted to the plot of Z' with $\omega^{-1/2}$.

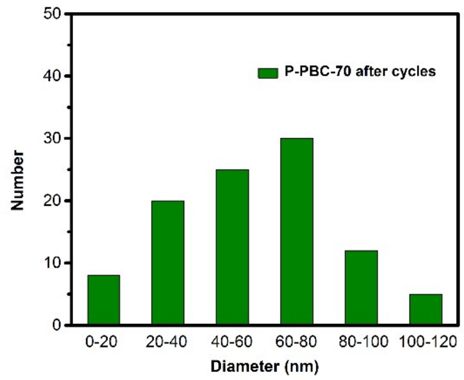

Fig. S18 The diameter distribution chart of P-PBC-70 electrode after 1000 cycles. In total, 100 nanofibers were analysed (N=100) to generate nanofiber numbers of N as a function of nanofiber diameter. Where the diameters are obtained by measuring the nanofibers in SEM images.