Electronic Supplementary Information

One-step production of N-O-P-S co-doped porous carbon from Bean worm for supercapacitors with high performance†

Zhentao Bian,[*a,b] Chunjie Wu,[a] Chenglong Yuan,[a] Ying Wang,[a] Guangzhen Zhao,[a] Hongyan Wang,[a] Yong Xie,[a,b] Cong Wang,[a] Guang Zhu[a] and Chong Chen[*a]

[a] Anhui Key Laboratory of Spin Electron and Nanomaterials (Cultivating Base), School of Chemistry and Chemical Engineering, Suzhou University, Suzhou 234000, PR China

[b] Institute of fine chemical products development, Suzhou University, Suzhou 234000, PR China

*Corresponding author:

E-mail: zhentaobian@126.com (Zhentao Bian);

chongchen_li@163.com (Chong Chen)

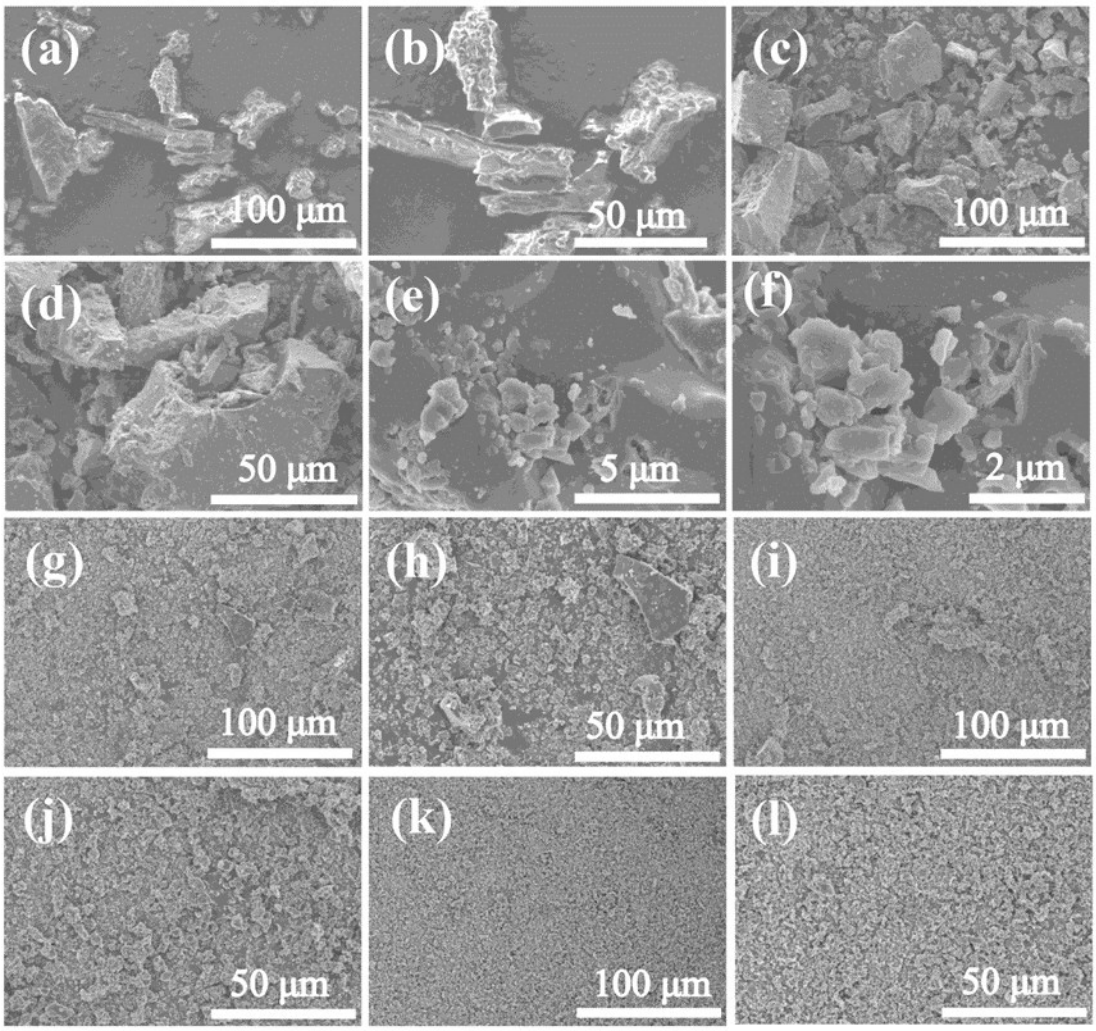

Fig. S1 SEM images of (a, b) precursor, (c, d, e, f) BWC, (g, h) $BWPC_{1/4}$, (i, j) $BWPC_{1/3}$ and (k, l) $BWPC_{1/2}$.

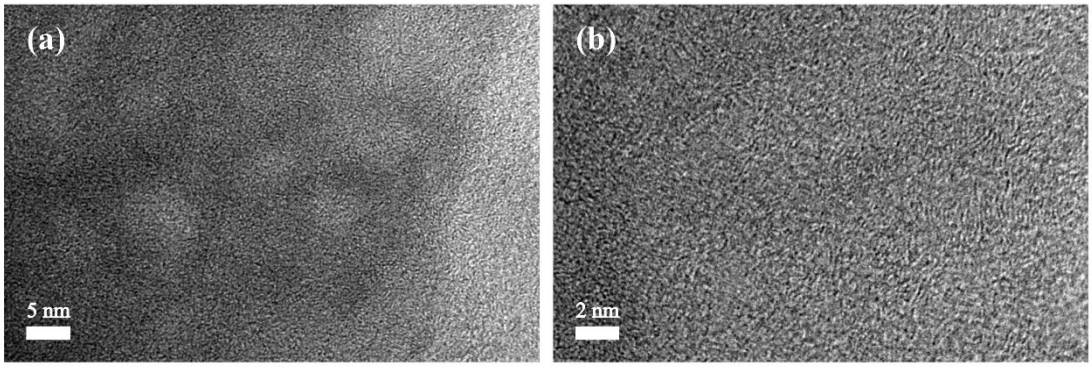

Fig. S2 High-resolution transmission electron microscopy (HRTEM) images of $BWPC_{1/3}$.

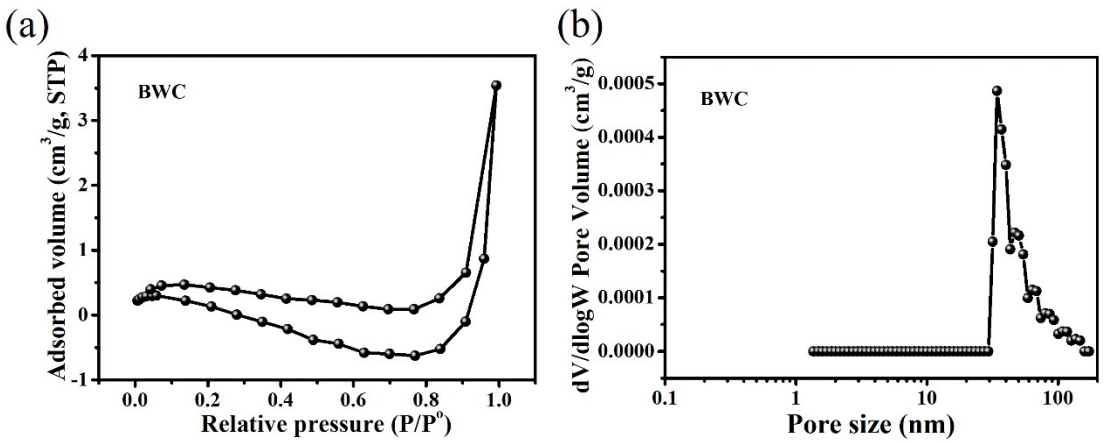

Fig. S3 (a) Nitrogen adsorption-desorption isotherms and (d) pore size distributions of BWC.

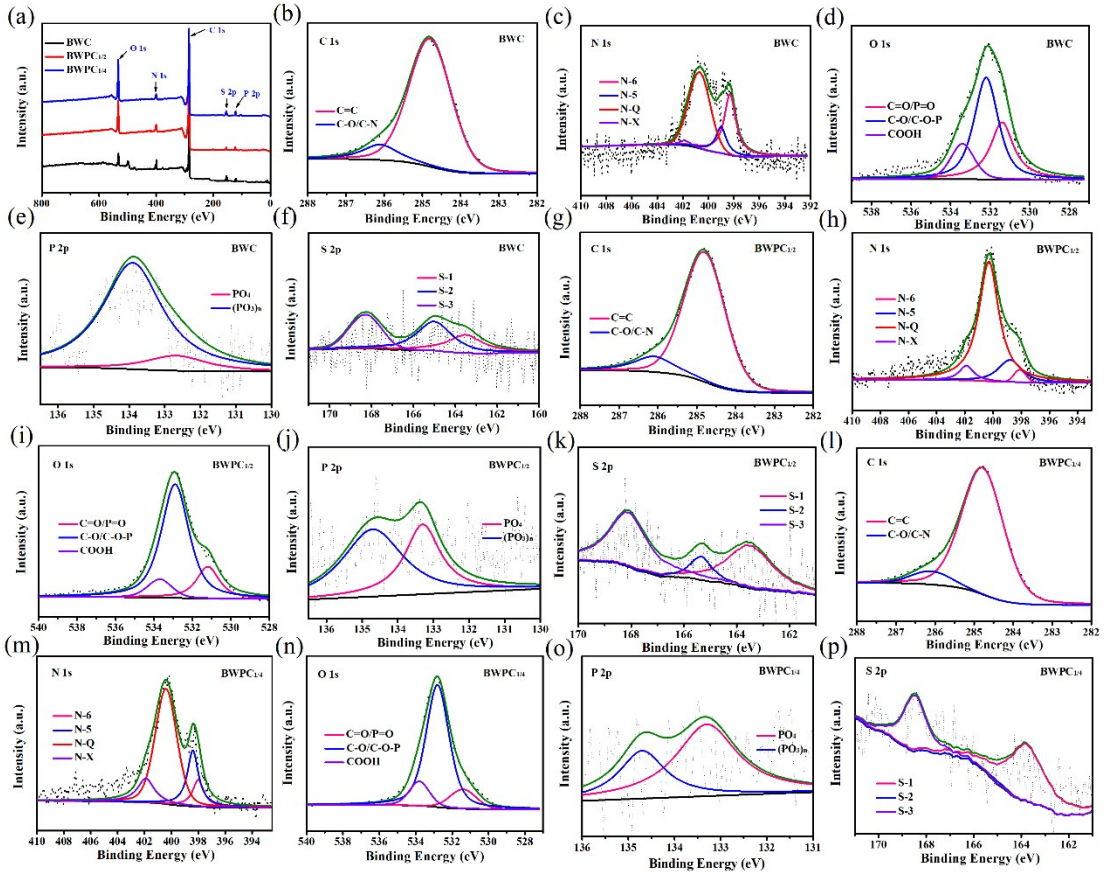

Fig. S4 XPS spectra (a) and deconvolved C1s spectra (b, g, l), N 1s spectra (c, h, m) O 1s spectra (d, i, n), P 2p spectra (e, j, o) and S 2p (f, k, p) of BWC, $BWPC_{1/2}$ and $BWPC_{1/4}$.

Table S1 The elemental content of C, N, O, P, and S in BWC and BWPCs.

Sample	BWC	$BWPC_{1/4}$	$BWPC_{1/3}$	$BWPC_{1/2}$
C species		Content (at. %)		
C=C	88.52	91.68	87.53	87.0
C-O/C-N	11.48	8.32	12.47	13.0
N species		Content (at. %)		
N-6	33.36	9.5	6.2	3.25
N-5	12.96	19.72	36.25	15.02
N-Q	51.37	58.19	50.18	75.05
N-X	2.31	12.6	7.38	6.67
O species		Content (at. %)		
C=O/P=O	32.37	11.59	11.41	17.93
C-O/ C-O-P	52.3	76.11	76.93	72.87
C-OOH	15.33	12.3	11.66	9.2
P species		Content (at. %)		
PO_4	12.0	66.67	34.48	40.0
$(PO_3)_n$	88.0	33.33	65.52	60.0
S species		Content (at. %)		
S-1	27.4	62.75	16.52	41.21
S-2	41.1	1.96	37.43	11.18
S-3	31.5	35.29	46.05	47.6

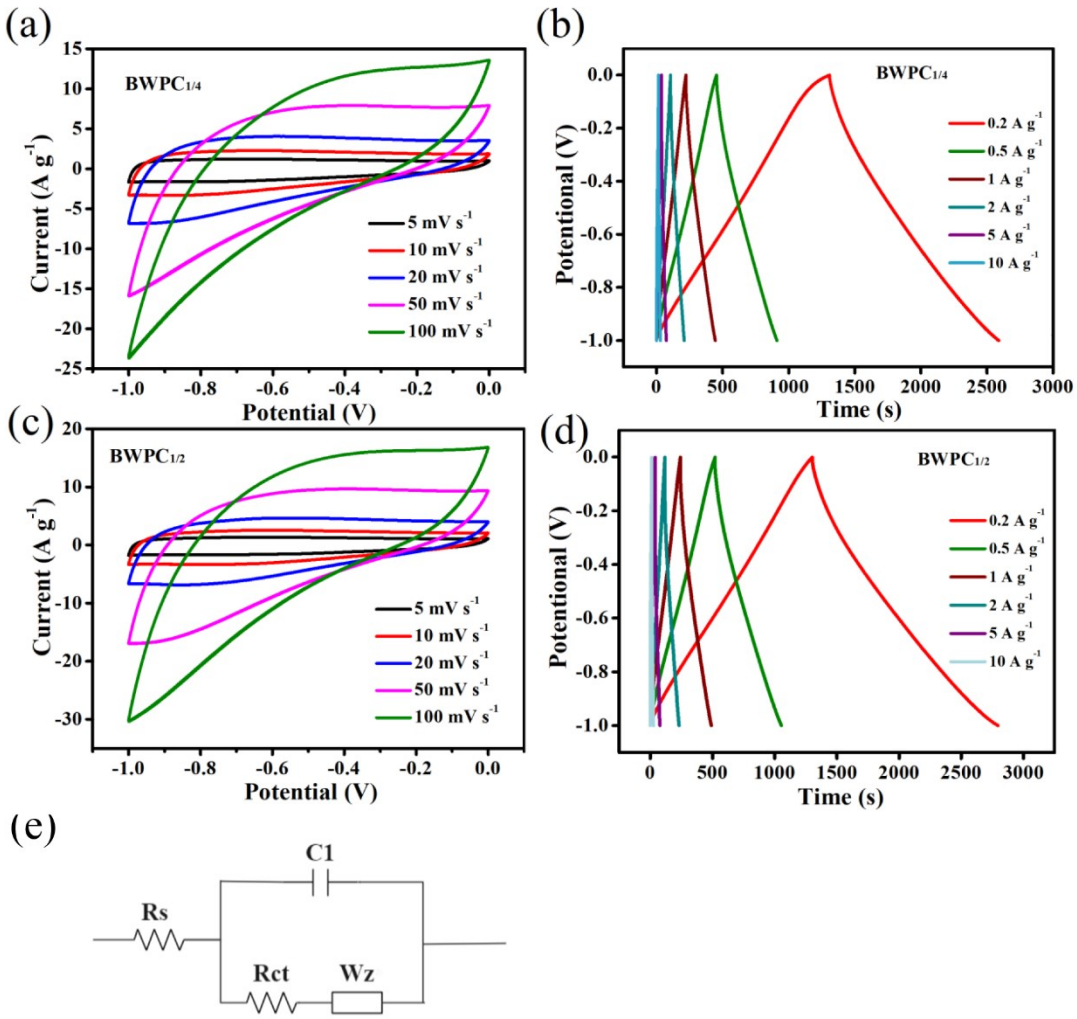

Fig. S5 Cyclic voltammograms curves for carbon electrodes obtained at the indicated conditions: (a) $BWPC_{1/4}$ and (c) $BWPC_{1/2}$. Galvanostatic charge-discharge curve for carbon electrodes obtained at the indicated conditions: (b) $BWPC_{1/4}$ and (d) $BWPC_{1/2}$. (e) equivalent circuit.

Table S2 Electrochemical features of BW-derived porous carbon supercapacitor.

Sample	Specific capacitance (C, F g^{-1})	R_s (Ω)	R_{ct} (Ω)	Energy density (E/Wh kg^{-1})	Power density (P/W kg^{-1})
BWC	-	0.87	22.01	-	-
$BWPC_{1/4}$	221.4 at 1A g^{-1}	0.81	7.75	-	-
$BWPC_{1/3}$	313.8 at 1A g^{-1}	0.76	3.11	27.5	200
$BWPC_{1/2}$	242.1 at 1A g^{-1}	0.84	5.46	-	-