Supporting Information

2D ultrathin carbon nanosheets with rich N/O content constructed by stripping bulk chitin for high-performance sodium ion batteries

Lingfeng Gao[a#], Jingqi Ma[b#], Shuping Li[b], Dajin Liu[b], Dingfeng Xu[a], Jie Cai[a], Lingyun Chen[c], Jia Xie[b*], Lina Zhang[a*]

[a]College of Chemistry and Molecular Sciences, Wuhan University, Wuhan 430072, P. R. China. *E-mail: zhangln@whu.edu.cn

[b]School of Electrical and Electronic Engineering, Huazhong University of Science and Technology, Wuhan 430074, P. R. China. *E-mail: xiejia@hust.edu.cn

[c]Department of Agricultural, Food & Nutritional Science, University of Alberta, Edmonton, AB, T6G 2P5 Canada.

#The authors contributed equally to this work.

*Corresponding authors.

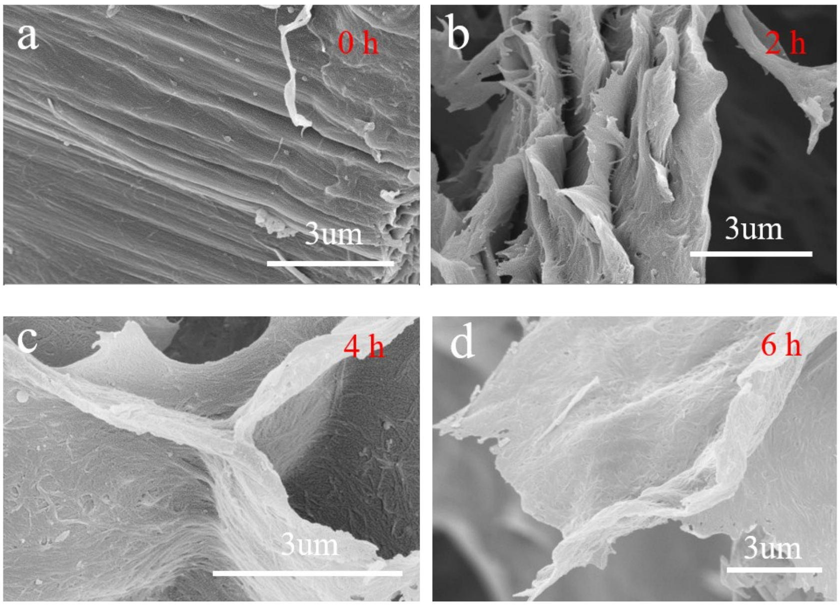


Fig. S1. (a-d) Exfoliation process of chitin nanosheets under hydrothermal treatment at different reaction time.

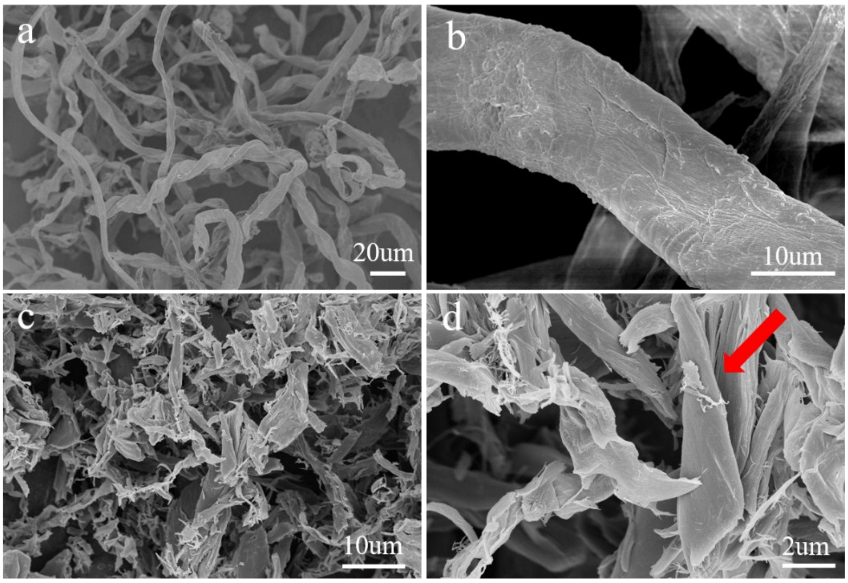


Fig. S2. SEM images of cotton linter before (a, b) and after (c, d) hydrothermal treatment.

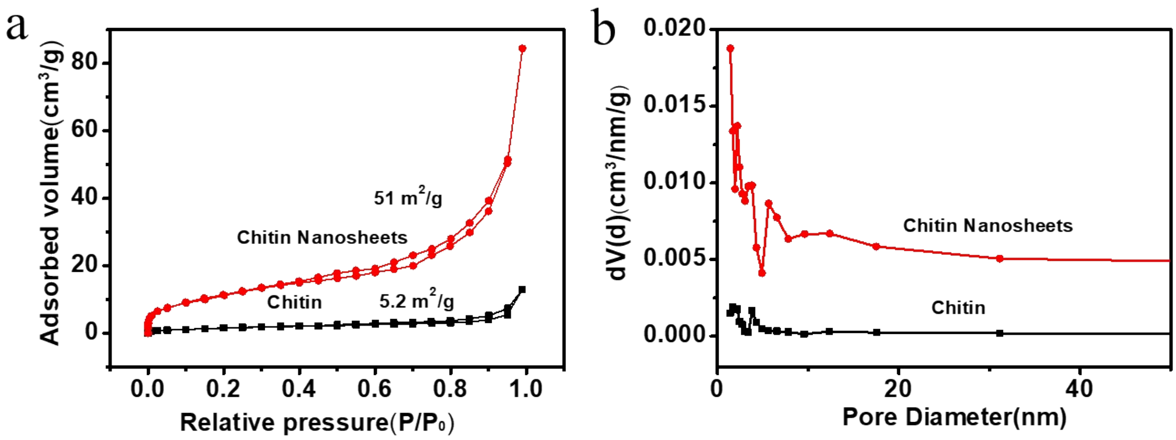


Fig. S3. (a) Nitrogen adsorption and desorption isotherms and (b) pore size distributions of chitin and chitin nanosheets.

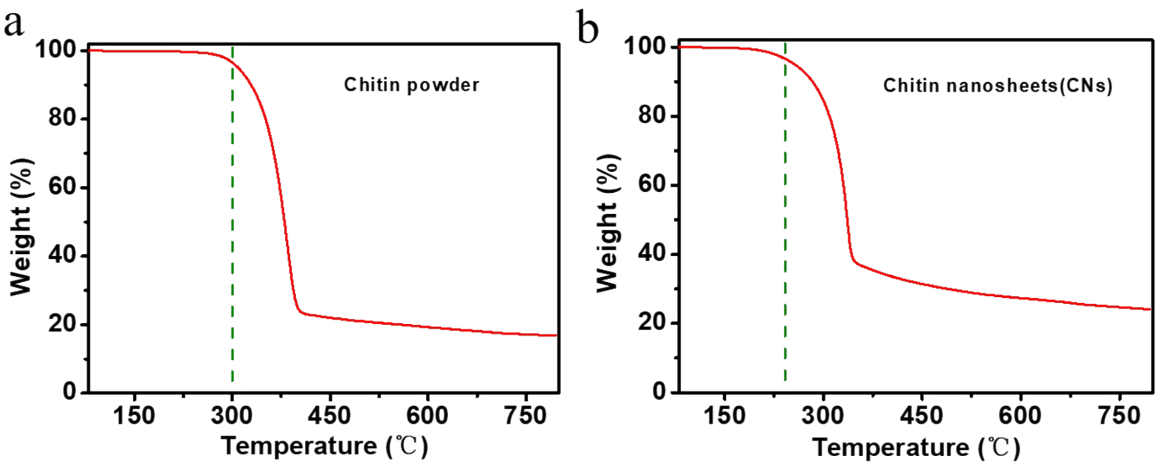


Fig. S4. Thermogravimetric analysis (TGA) of (a) chitin powder and (b) chitin nanosheets (CNs) under argon atmosphere.

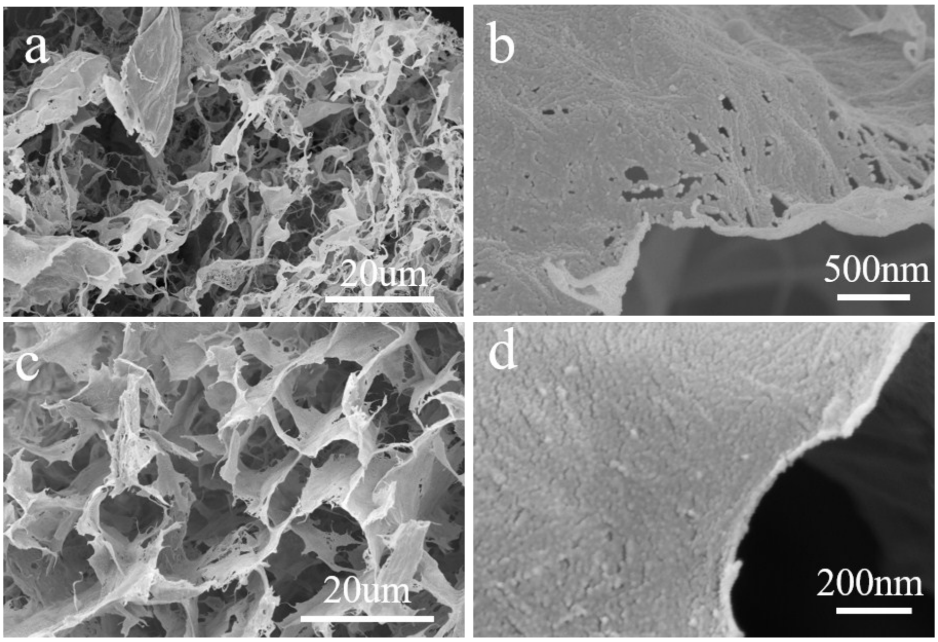


Fig. S5. SEM images of (a, b) CCNs-700 and (c, d) CCNs-800.

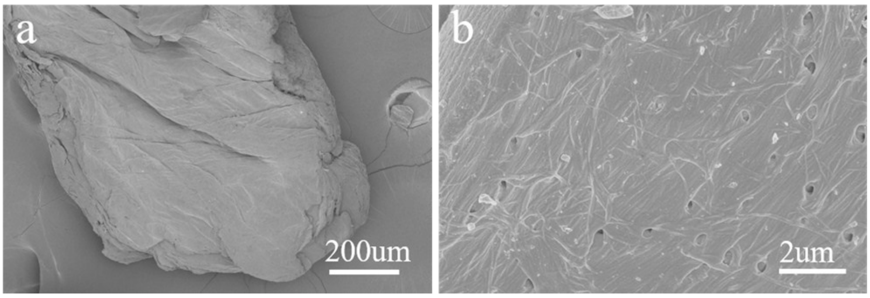


Fig. S6. (a, b) SEM images of CC-600 at different scale.

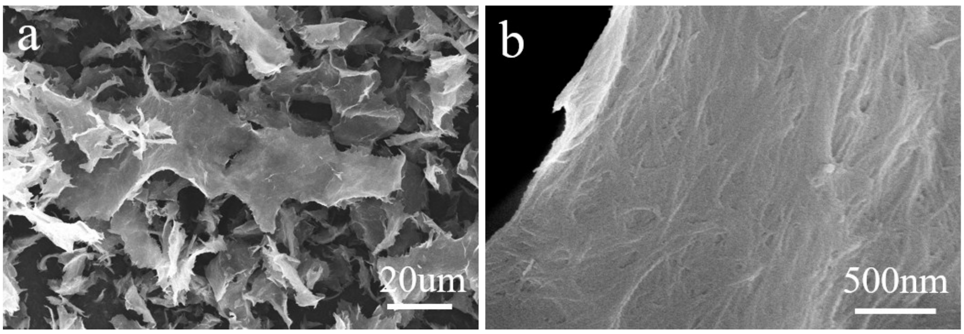


Fig. S7. (a, b) SEM images of CCNs-500 at different scale.

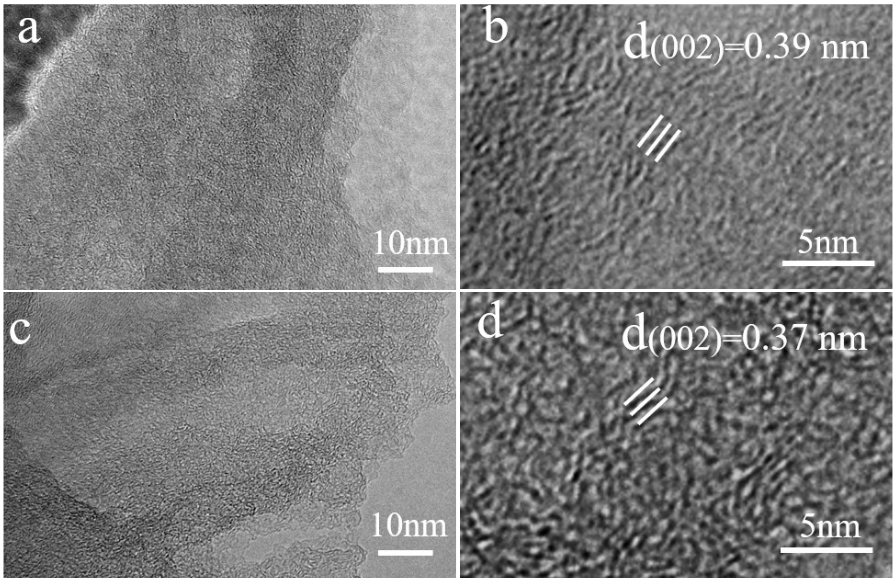


Fig. S8. TEM and HRTEM images of (a, b) CCNs-700 and (c, d) CCNs-800.

Table S1: Physical parameters of CCNs and CC-600 samples.

Samples	2θ	d_{002} (Å)	SSA (m^2/g)	Pore volume (cm^3/g)	Average pore size (nm)
CC-600	22.2	3.98	121	0.11	4.35
CCNs-600	22.2	3.98	262	0.23	3.49
CCNs-700	23.0	3.85	472	0.31	2.27
CCNs-800	24.1	3.69	586	0.34	1.94

Bragg's equation: $2d \sin\theta = n\lambda$.

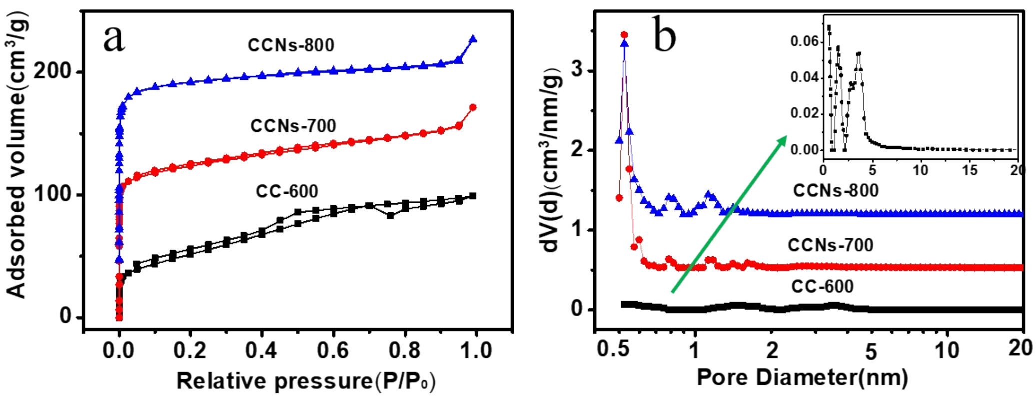


Fig. S9. (a) Nitrogen adsorption and desorption isotherms and (b) pore size distributions of CCNs and CC-600 samples.

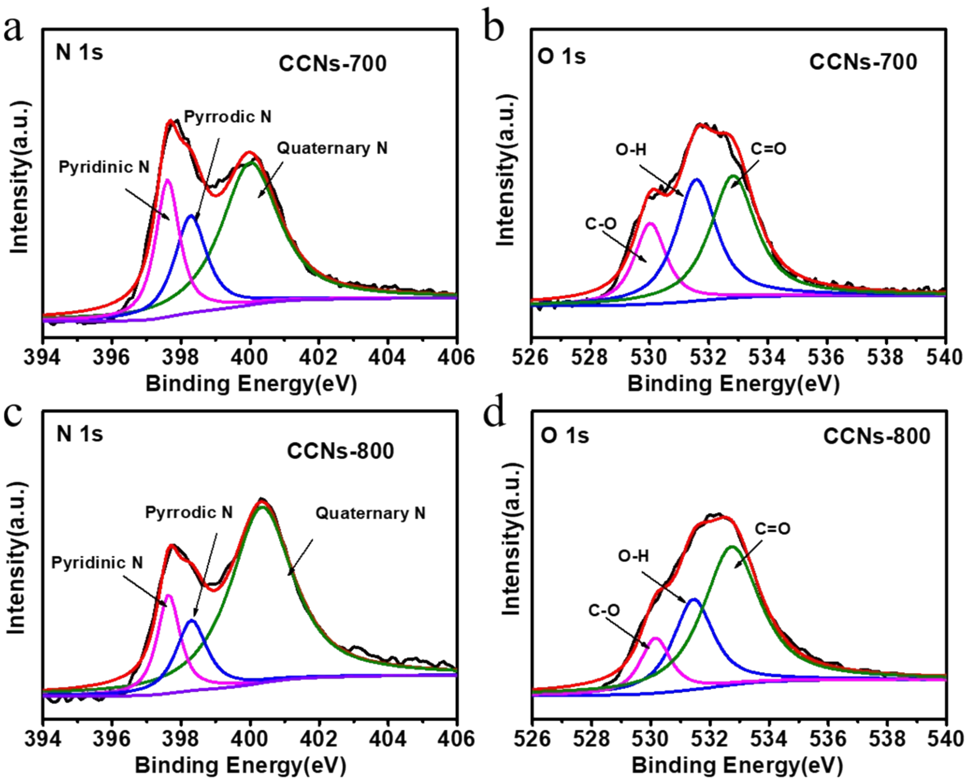


Fig. S10. High resolution of (a, c) N 1s and (b, d) O 1s for CCNs samples.

Table S2: The electronic conductivity results of different materials using direct current polarization method

Materials	Resistance (ohm)	Length (cm)	Area (cm^{-2})	Electronic conductivity (S/cm)
CCNs-500	10745.81	0.066	0.785	7.82×10^{-6}
CCNs-600	60.64	0.052	0.785	1.09×10^{-3}
CCNs-700	0.70	0.048	0.785	8.72×10^{-2}
CCNs-800	0.26	0.044	0.785	2.19×10^{-1}

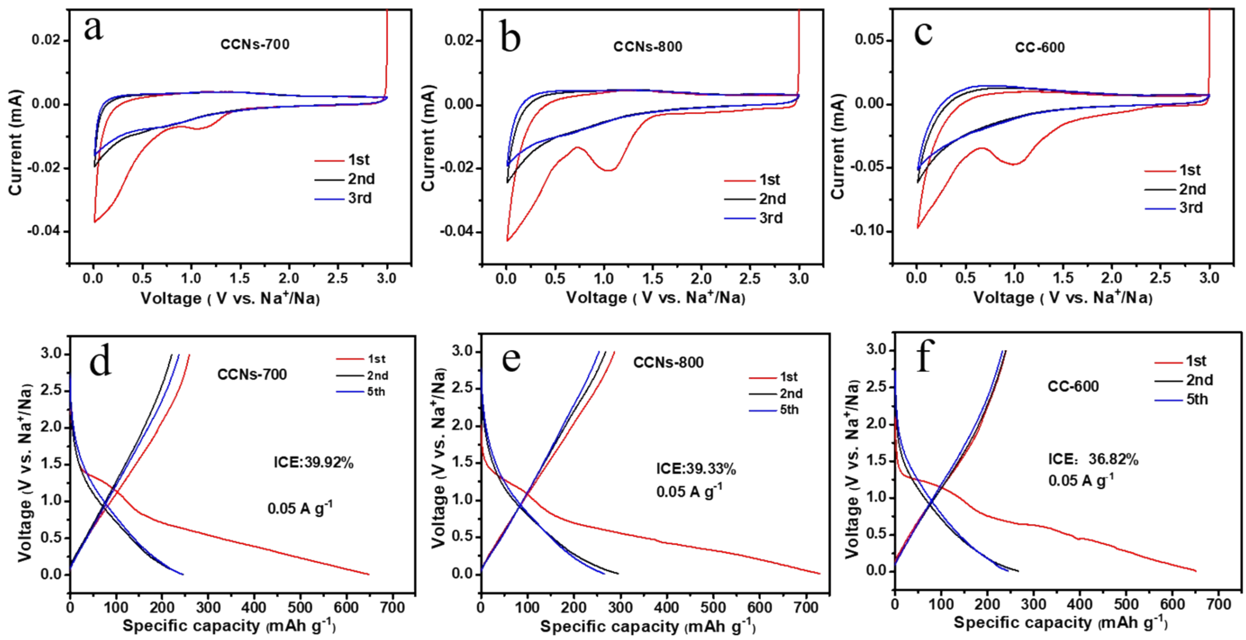


Fig. S11. (a, b, c) Typical CV curves at a scan rate of 0.2 mV/s and (d, e, f) galvanostatic charge–discharge curves of CCNs-700, CCNs-800, and CC-600, respectively.

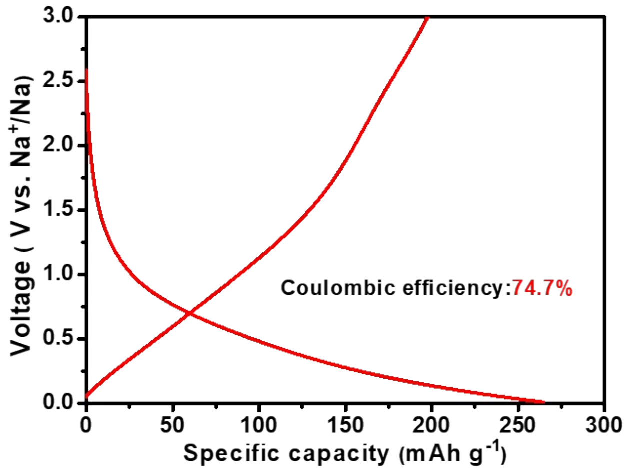


Fig. S12. Initial charge and discharge curves of CCNs-600 at current density of 50 mA g-1 after Pretreatment.

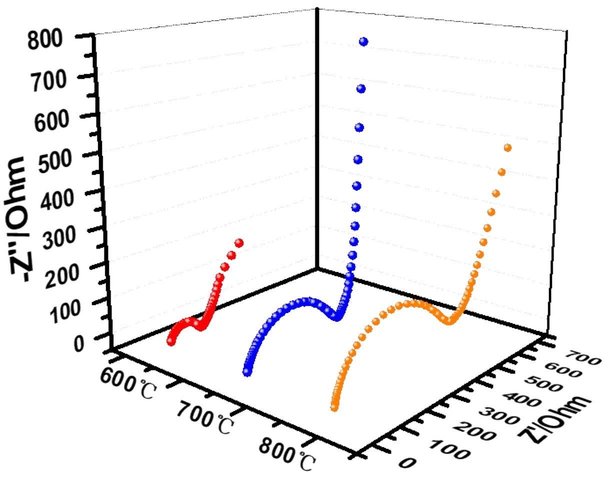
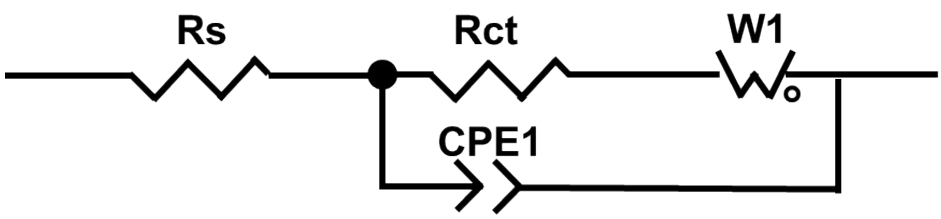


Fig. S13. Electrochemical impedance spectra of different CCNs samples with the frequency ranging from 100 KHz to 0.1 Hz.



Schematic S1. The schematic of Impedance fitting circuit

Table S3: The Impedance fitting values of CCNs-600, CCNs-700, CCNs-800

	Rs (Ω)	Rct (Ω)	CPE1-T (F)	CPE1-P (Ω)	W1-R (Ω)
CCNs-600	9.963	92.45	$5.3597E^{-06}$	0.87	35.05
CCNs-700	7.762	303.7	$5.0401E^{-06}$	0.86	141.4
CCNs-800	5.819	379.4	$4.5282E^{-06}$	0.91	299.6

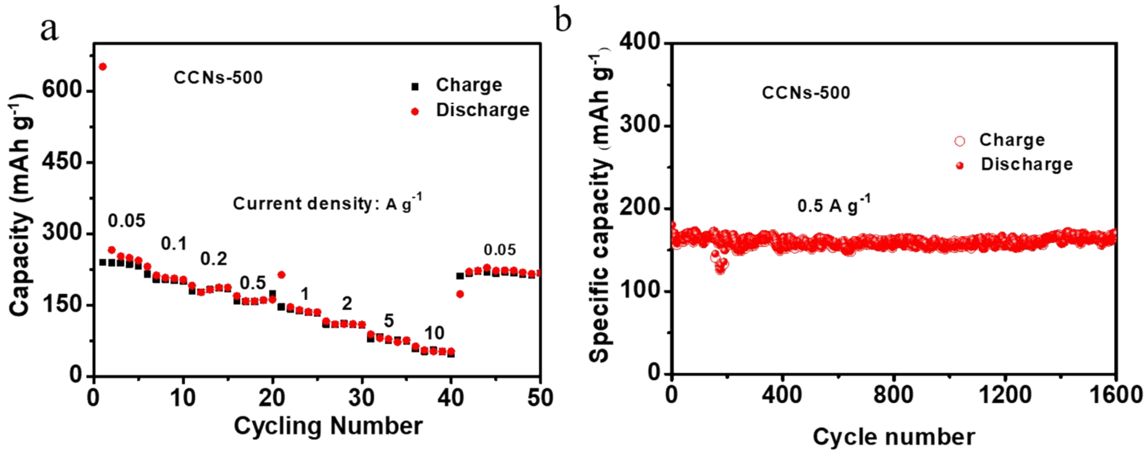


Fig. S14. (a) Rate property and (b) cycling performance of CCNs-500 under 0.5 A g^{-1}.

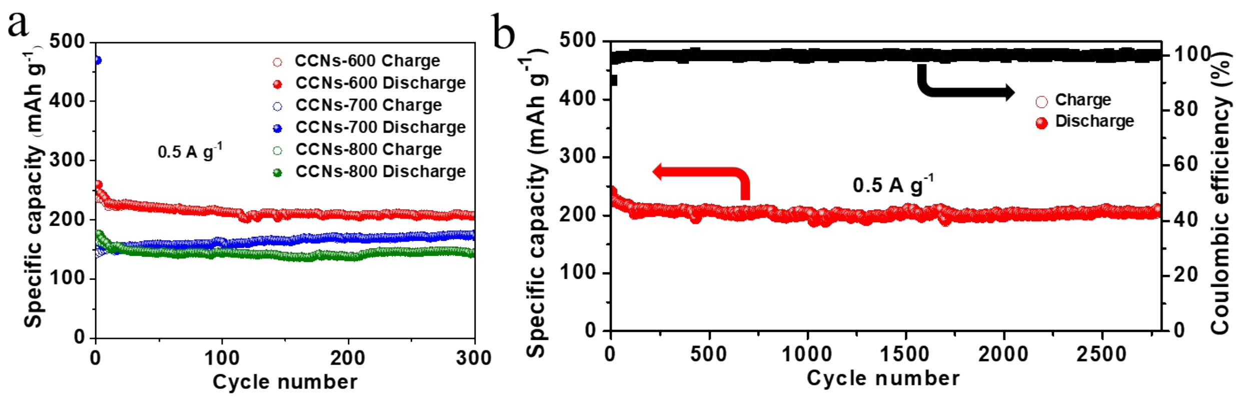


Fig. S15. (a) Cycling performance of different CCNs samples at a current density of 0.5 A g^{-1}, (b) cycling performance of CCNs-600 for over 2500 cycles.

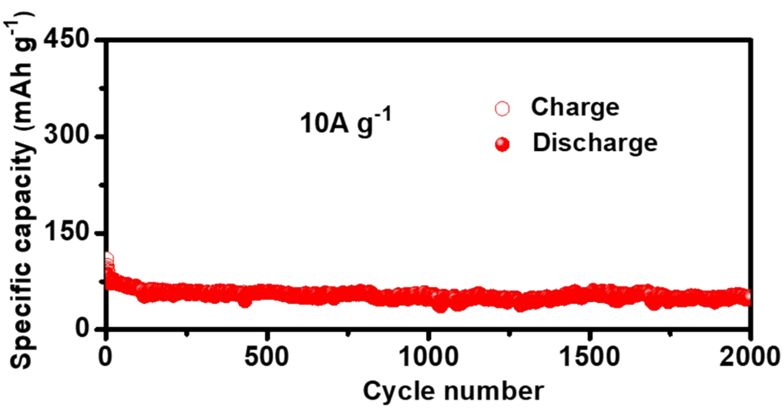


Fig. S16. Cycling performance of different CCNs-600 at a current density of 10 A g^{-1}

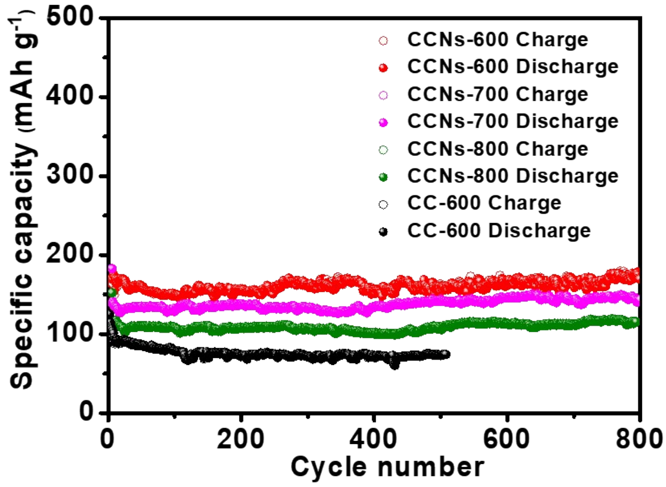


Fig. S17. Cycling performance of different CCNs samples at a current density of 2 A g^{-1}

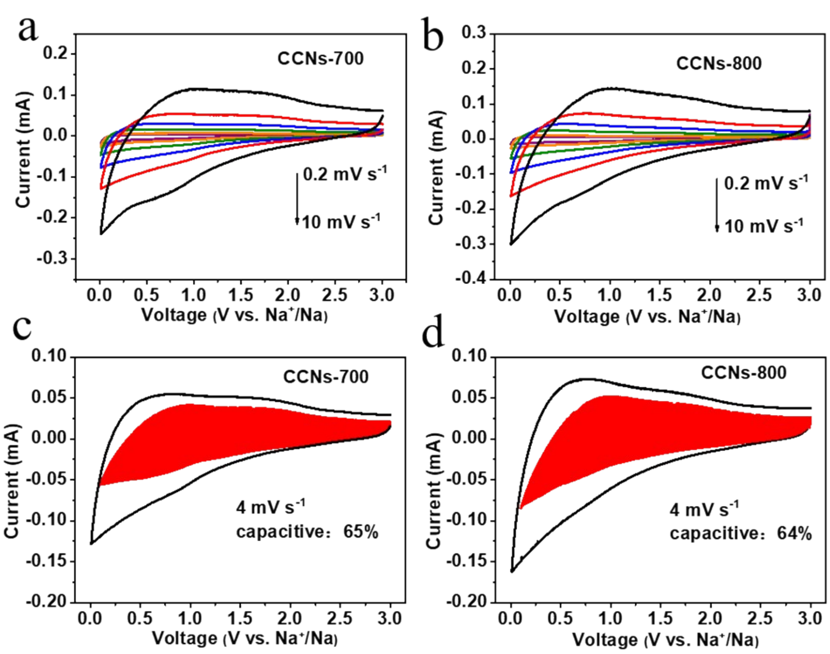


Fig. S18. (a, b) CV curves of the different CCNs electrode at various scan rates, (c, d) CV curve of the different electrode at 4 mV s^{-1} with the shadowed area representing the surface capacitive contribution.

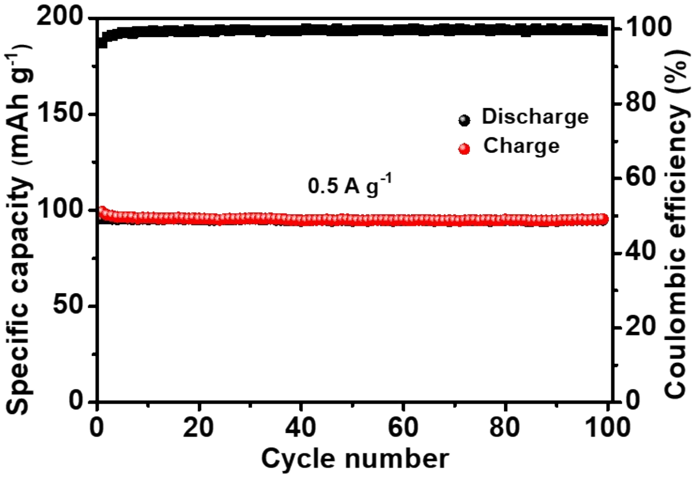


Fig. S19. The cycling performance of $Na_3V_2(PO_4)_3$ cathode at 0.5 A g^{-1} with a voltage platform of 3.4 V.

Supplementary method S1: calculation details of the capacitive charge contributions According to the power law relationship of $i = av^{1/2}$ for diffusion limited processes and $i = av$ for non-diffusion limited processes, the total current containing contributions from the two type of processes can be described as: $i(V) = k_1v^{1/2} + k_2v$ and $i(V)/v^{1/2}= k_1 + k_2v^{1/2}$. The current values at a fixed voltage can be determined by the cyclic voltammograms at various scan rates of 0.2-10 mV s-1. By drawing plots of $i/v^{1/2}$ vs. $v^{1/2}$, the values of k_1 (intercept) and k_2 (slop) at a fixed voltage can be calculated. By introducing the series k_1 and k_2 values at different voltages into $k_1v^{1/2}$ and k_2v, the diffusion-controlled and capacitive currents can be determined, respectively.