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Graphene induced N/O doping and structural regulation of carbon nanofibers for enhanced sodium storage

Yuancheng He, Zhimeng Shen, Shujun Zhang, Gaobo Chang, Cheng Huang, Zhong Li*and Hanqing Zhao*

State Key Laboratory of Clean and Efficient Coal Utilization, College of Chemical Engineering and Technology, Taiyuan University of Technology, Taiyuan 030024, Shanxi, China

** Corresponding author.*
E-mail address: lizhong@tyut.edu.cn (Z. Li), zhaohanqing@tyut.edu.cn (H. Zhao)

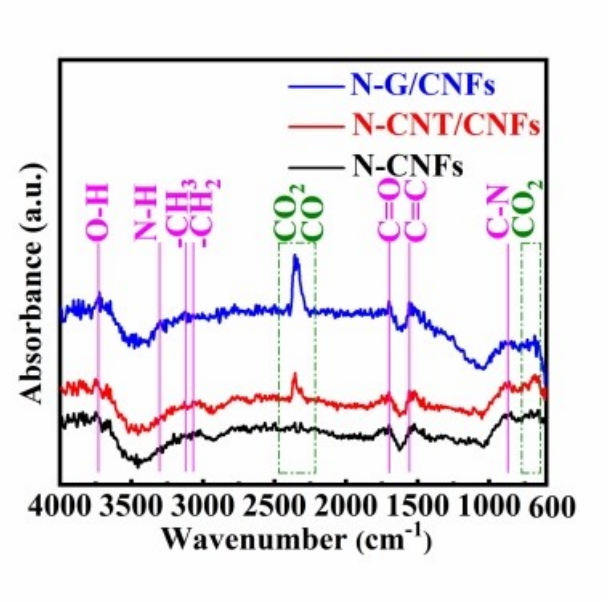

Figure S1. FTIR spectra of all samples.

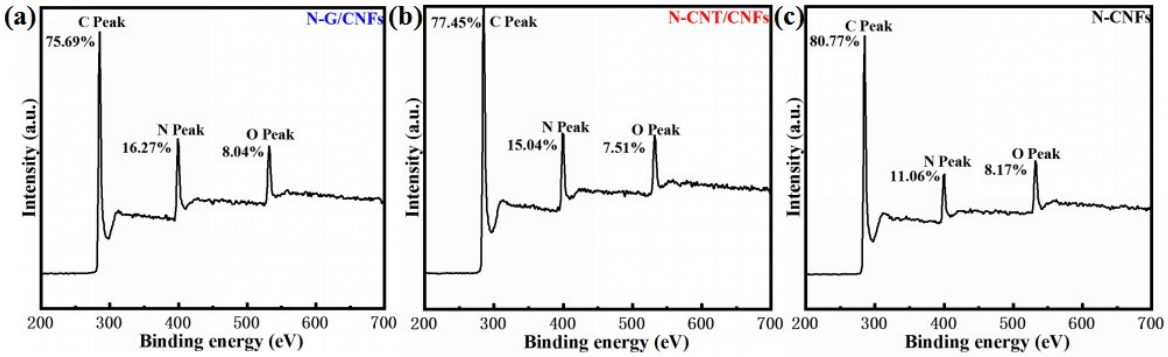

Figure S2. XPS survey spectra of (a)N-G/CNFs, (b)N-CNT/CNFs,(c)N-CNFs.

The nitrogen contents are 16.27 at%, 15.04 at% and 11.06 at% for N-G/CNFs, N-CNT/CNFs and N-CNFs, respectively. The oxygen content are 8.04 at%, 7.51 at% and 8.17 at% for N-G/CNFs, N-CNT/CNFs and N-CNFs, respectively.

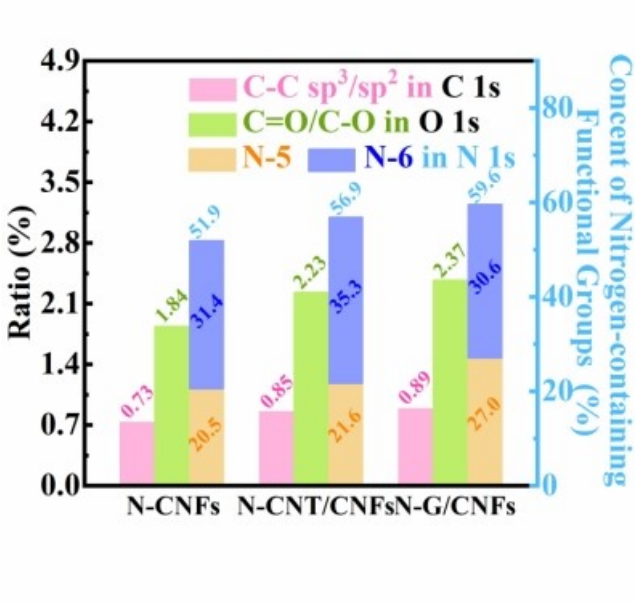

Figure S3. Relative content chart about each functional group content in XPS C 1s, O 1s and N 1s spectrum of all samples.

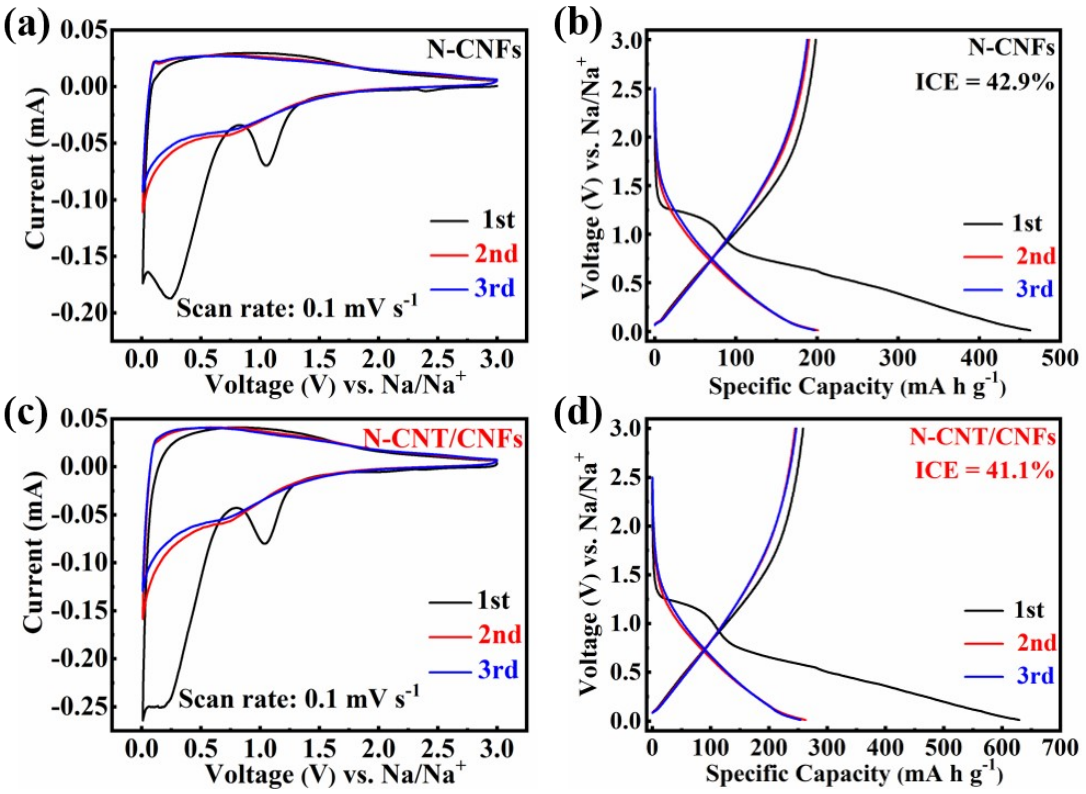

Figure S4. CV curves of (a) N-CNFs and (c) N-CNT/CNFs. Galvanostatic charge/discharge profiles of (b) N-CNFs and (d) N-CNT/CNFs

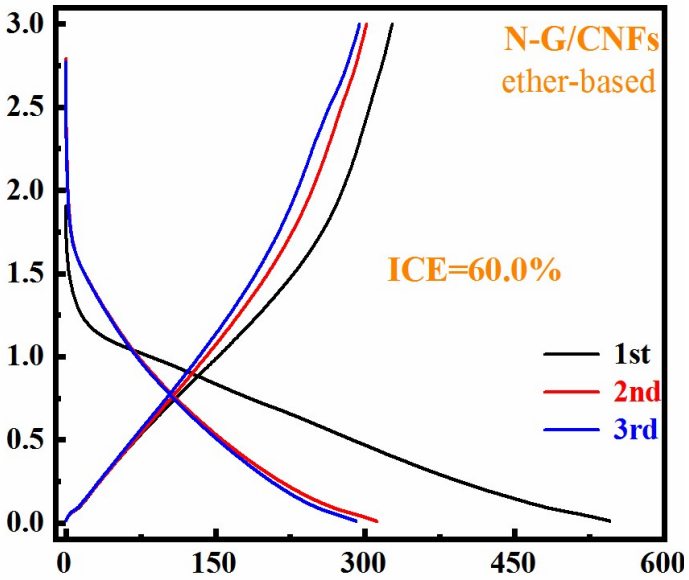

Figure S5. Galvanostatic charge/discharge profiles of N-CNT/CNFs using an ether-based electrolyte.

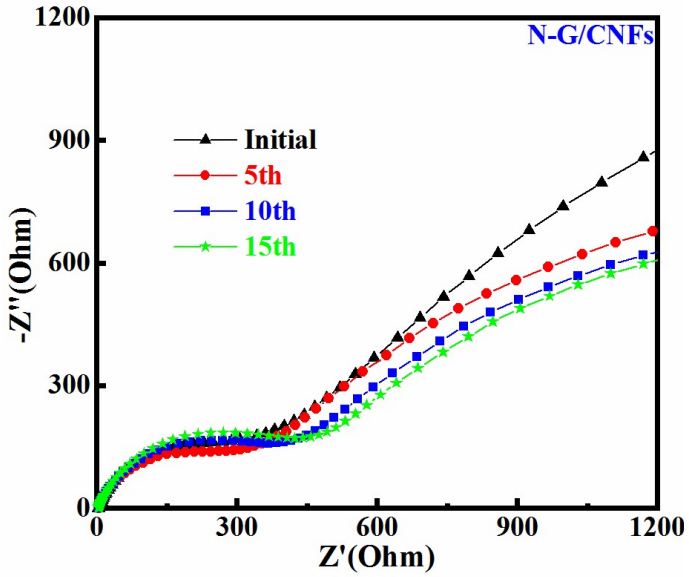

Figure S6. Nyquist plots of 0,5,10,15 for N-G-CNFs at a current density of 0.2 A g^{-1}.

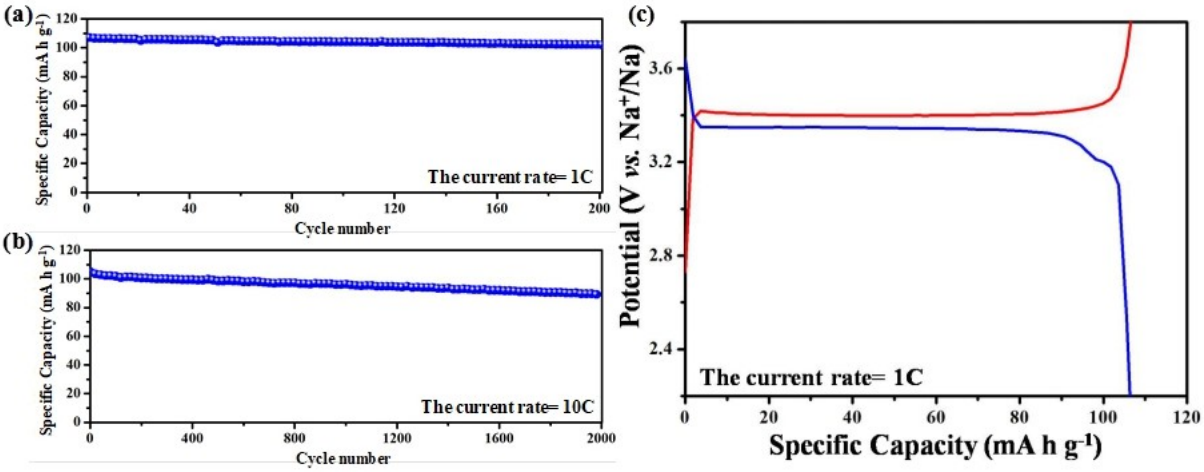

Figure S7 Cycling performance of N-G/CNFs at (a) 1C, (b) 10C, Galvanostatic charge/discharge profiles of $Na_3V_2(PO_4)_3$@C.

The reversible capacities are ~100/85 mA hg^{-1} at 1 C/10 C after 200/2000 cycle. In addition, the capacity retention rates are ＞80%.According to the 1C charge discharge curve, sodium vanadium phosphate has a pair of charge discharge platforms, which are caused by the redox reaction between V^{3+}/V^{4+}.

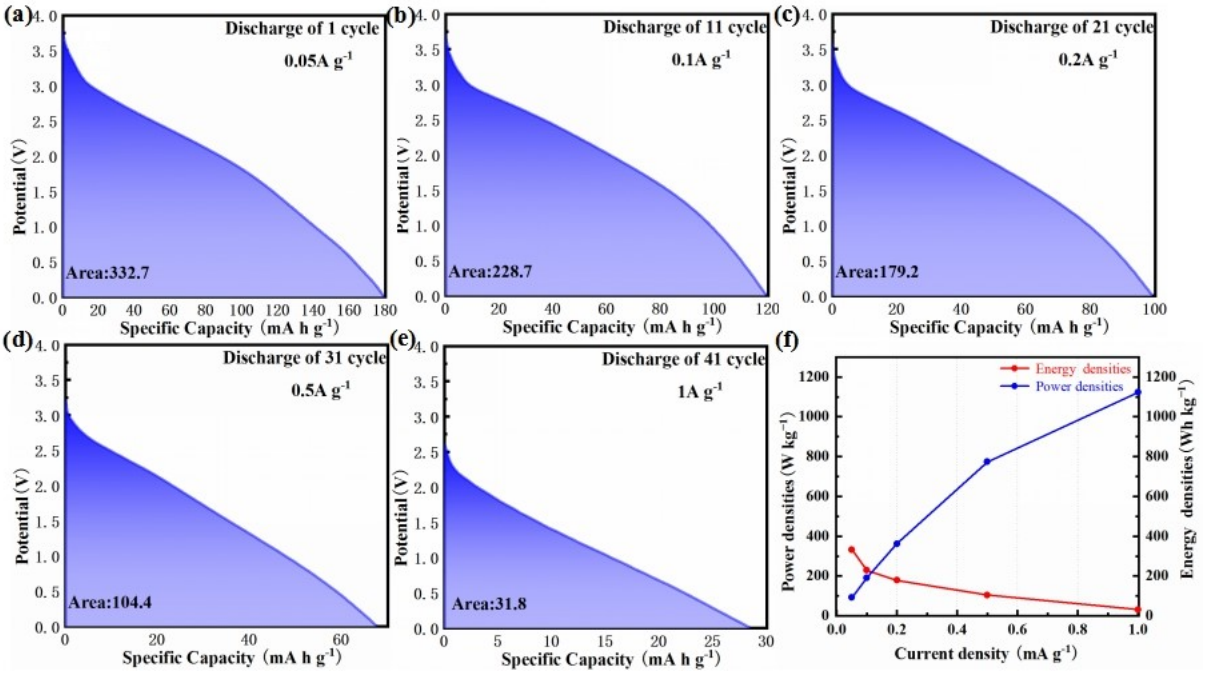

Figure S8.The discharge profile of the full-cell at (a) 0.05 A g^{-1}, (b) 0.1 A g^{-1}, (c) 0.2 A g^{-1}, (d) 0.5 A g^{-1} and (e) 1 A g^{-1}according to the test. . (f) the energy and power densities at different current densities.

The calculation of the energy density for full cell-is based on the following equations:

$$E = \frac{\partial \varphi}{\partial C}$$

$$P = \frac{E}{t/3600}$$

where E and P indicate the energy and power densities, respectively.φ means discharging potential, C indicates the discharging capacity, t means the total discharging time.

Based on the experimental results of the first cycle discharge at different current densities (0.05, 0.1, 0.2, 0.5, and 1 A g^{-1}), the corresponding discharge times were measured as 12904, 4291, 1783, 486, and 102 seconds, respectively. From these measurements, the energy densities were calculated to be 332.7, 228.7, 179.2, 104.9, and 31.8 Wh kg^{-1}, and the power densities were determined to be 92.8, 191.9, 361.8, 773.3, and 1122.4 W kg^{-1}, respectively.

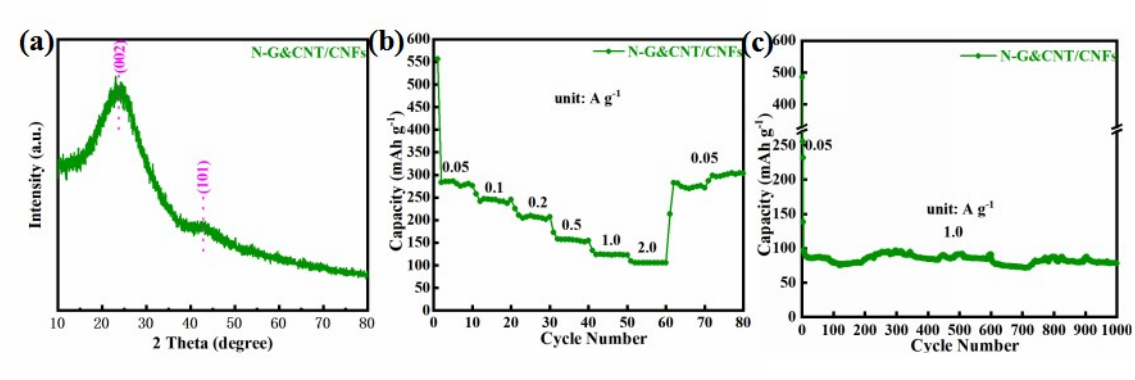

Figure S9. (a) XRD patterns of N-G&CNT/CNFs. (d) Rate capability performance of N-G&CNT/CNFs. (e) Cycling performance of N-G&CNT/CNFs at 1 A g^{-1}.

(a) In the XRD patterns of N-G&CNT/CNFs, two wide peaks are observed at around 24.4° and 43.0°, corresponding to the carbon (002) and (101) characteristic peaks respectively.The (002) peaks for the N-G&CNT/CNFs are centered at around 24.4°, corresponding to the interlayer distances (d_{002}) of 3.64Å.

(b) The N-G&CNT/CNFs electrode displays high reversible capacities of 284, 245, 208, 155, 123 and 105mA h g^{-1} at 0.05, 0.1, 0.2, 0.5, 1 and 2 A g^{-1}, respectively.

(c) At 1 A g^{-1} after 1000 cycles, its reversible capacity still remains at 78 mA h g^{-1}.

Table S1. The fitting results of electrochemical impedance spectra.

Sample	R_s (Ω)	R_{SEI} (Ω)	R_{ct} (Ω)
N-CNFs	5.0	65.4	846.0
N-CNT/CNFs	2.9	22.9	352.0
N-G/CNFs	3.7	20.0	323.7

Table S2 Comparison of the energy and power densities of various $Na_3V_2(PO_4)_3$ (NVP) for sodium-ion batteries

Sample	Energy densities (Wh kg^{-1})	Power densities (W kg^{-1})	Ref
$Na_3V_2(PO_4)_3$@C//N-G/CNFs	104.9	773.3	Our work
HP-NVP@SC	164	-	[1]
M-$Na_2Fe_2(CN)_6.2H_2O$//graphite full cell	88.4	-	[2]
NVP@rGO microsphere	242	4560	[3]
NVP/F	90	6000	[4]
$Na_3V_2(PO_4)_3$/AC	185.5	5000	[5]

Notes and references

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