Low-surface-area nitrogen doped carbon nanomaterial for advanced sodium ion batteries

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Experimental Details

Synthesis of Materials

The low-surface-area nitrogen doped carbon nanomaterial was synthesized by a facile annealing method. PB and glucose (30 wt%) were mixed in the mixture of alcohol and water, and then ground in a mortar to ensure that the slurry was mixed fully homogeneous. After being placed in an air-dry oven (80 °C for 4h), the compound was calcined at 550 °C for 6 hours in an Ar atmosphere, and then exposed in air at room temperature to form with nano-Fe₂O₃ coated with graphene analogue carbon nanosheets (Fe₂O₃@C). Finally, the Fe₂O₃@C were washed by H₂SO₄ (98% H₂SO₄: H₂O=1:1, volume ratio) to remove the Fe₂O₃ and obtain NC-550. The NC-650 was prepared by a similar treatment but calcined at different temperatures.

Material characterization

The morphology of the prepared particles was characterized by scanning electron microscopy (SEM, ZEISS Supra 55) and transmission electron microscopy (TEM, FEITecnaiG230). The structural information of the particles was obtained by a powder X-ray diffraction system (XRD, Buker D8 Advance diffractometer) with Cu-K α radiation (λ =1.54Å). Raman spectra were collected on a HORIBA Jobin Yvon spectrometer. X-ray photoelectron spectroscopy (XPS) measurements were performed using KRATOS Axis Ultra (Kratos Analytical, Manchester, United Kingdom) to investigate elementary composition on the surface.

Electrochemical measurements

The 2032 coin cells were assembled in an argon-filled glovebox to determine the electrochemical performance. The working electrodes were fabricated with 70 wt % active material, 20 wt % carbon black, and 10 wt % poly(vinylidene fluoride) binder, using sodium disc as the counter electrode, glass fiber as the separator, and 1 M NaClO₄ in EC and DEC (1:1, volume ratio) with the addition of 5% fluorinated ethylene carbonate (FEC) as the electrolyte. Galvanostatic discharge/charge tests were carried out on a NEWARE battery cycler over a voltage range of 0.01-3.0 V (vs. Na⁺/Na) at room temperature. The cyclic voltammetry (CV) measurement was performed on a CHI 604E electrochemical workstation.

	0		С				N		
	19.8%		64.3%				15.9%		
55	C=O	C-O	O=C-	C=N	C-	C=C	Pyrroli	Pyridini	Quaternar
0			N		OH		c N	c N	y N
	67.8	32.2	19.8	24.8	19.1	36.3	21.7%	66.8%	11.5%
	%	%	%	%	%	%			
	14.2%		73%				12.8%		
65	C=O	C-O	O=C-	C=N	C-	C=C	Pyrroli	Pyridini	Quaternar
0			N		OH		c N	c N	y N
	55.1	44.9	19.9	18.8	13.4	47.9	31.4%	45.6%	23%
	%	%	%	%	%	%			

Table S1. Contents of O 1s, C 1s, and N 1s of NC-550 and NC-650



Figure S1. (a) XPS survey spectrum (b) O 1s and (c) C 1s of NC-550 (d) XPS survey spectrum (e) O 1s and (f) C 1s of NC-650



Figure S2.Charge-discharge profiles of NC-550 (a) and NC-650 (b).



Fig. S3 kinetic analysis of the NC-550: (a) CV curves at different scan rates. (b) (c) plots of $v^{1/2} vs i / v^{1/2}$ used to calculate k_1 and k_2 at different potentials (d) (e) b values calculation at different potentials.



Fig. S4 Kinetic analysis of the NC-650: (a) CV curves at different scan rates. (b) (c) plots of $v^{1/2} vs$ i/ $v^{1/2}$ used to calculate k_1 and k_2 at different potentials (d) (e)b values calculation at different potentials.



Fig. S5 b-values obtained from the slope of the peak current *versus* the CV scan rate on a logarithmic scale at different anodic and cathodic peak positions