Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting Information

Oxygen-deficient vanadium oxides@N-doped carbon heterostructure for sodium-ion batteries: insights into charge storage mechanism and enhanced reaction kinetics

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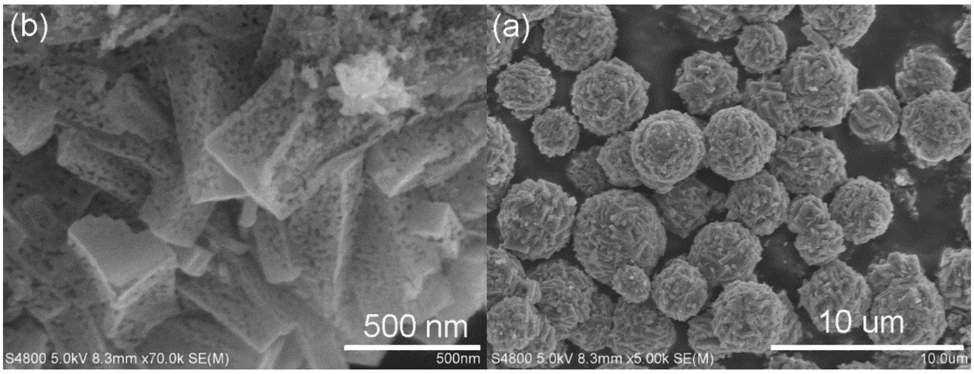

Fig. S1. SEM images of the VC product, showing porous spherical morphology with a hierarchical structure.

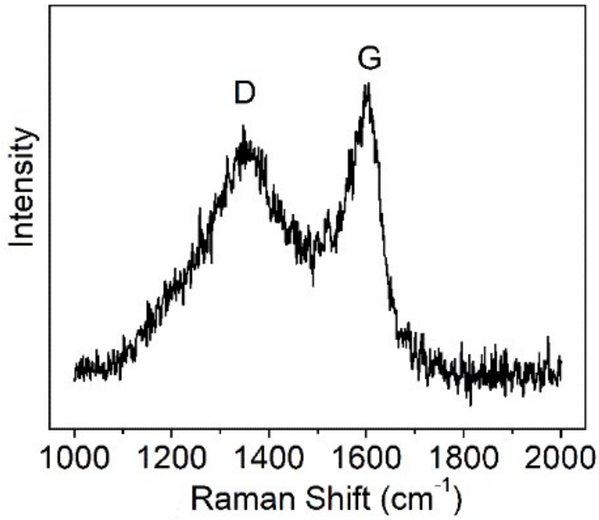

Fig. S2. Raman spectrum of VNC sample, indicating the presence of carbon species.

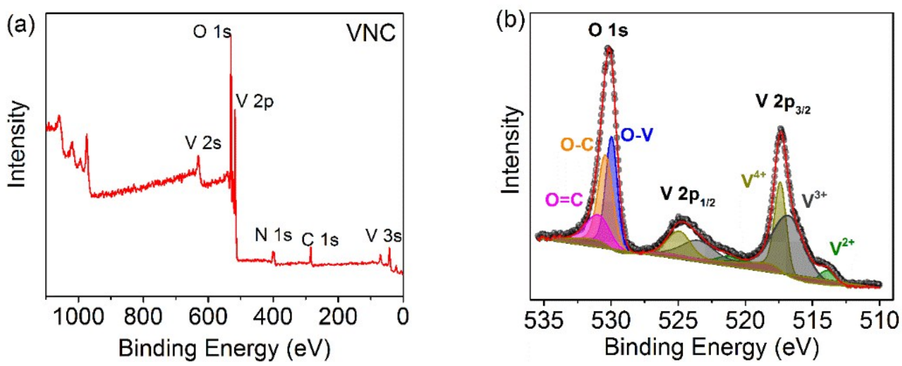

Fig. S3. (a) Survey and (b) high-resolution O 1s and V 2p XPS spectra of VNC sample.

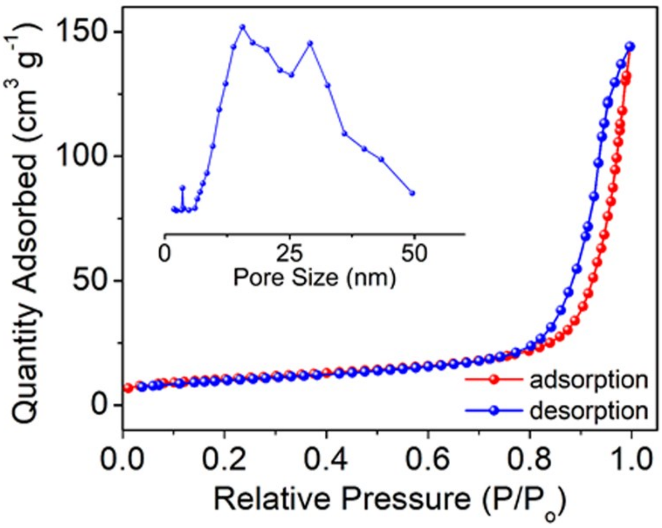

Fig. S4. N_2 adsorption/desorption isotherm curves and pore size distribution plot (inset) of vanadium oxides@N-doped C hybrid sample.

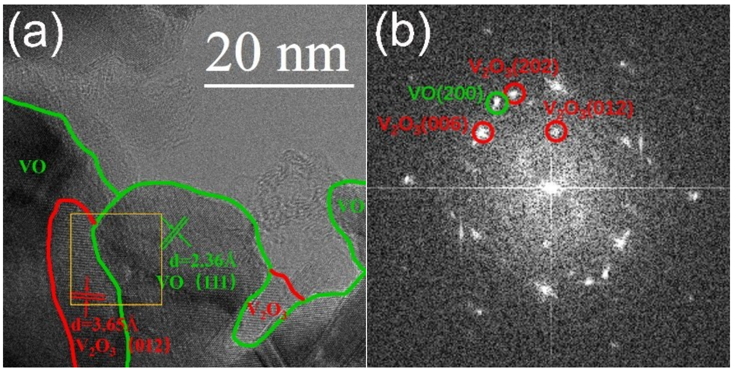

Fig. S5. HRTEM (a) and FFT pattern (b) derived from the dark-yellow square region in (a) of the VNC sample, showing the coexistence of VO and V_2O_3 nanocrystals as marked by green and red, respectively.

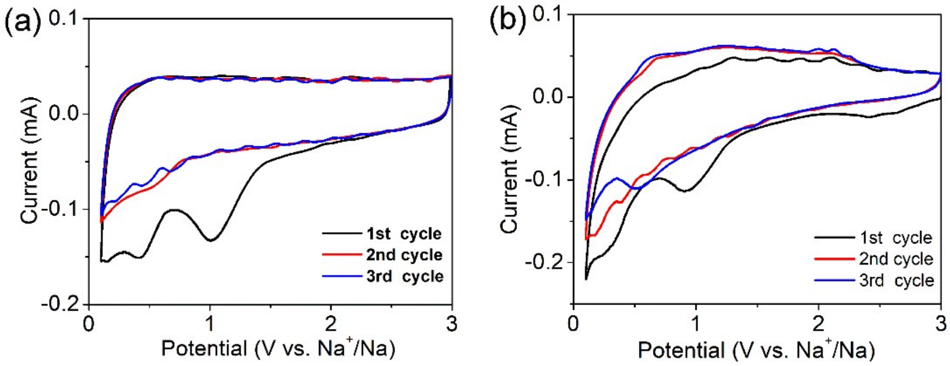

Fig. S6. Cyclic voltammetry (CV) curves of the VNC (a) and VC (b) electrodes in Na-half cells at 0.2 mV s^{-1} in the first three cycles.

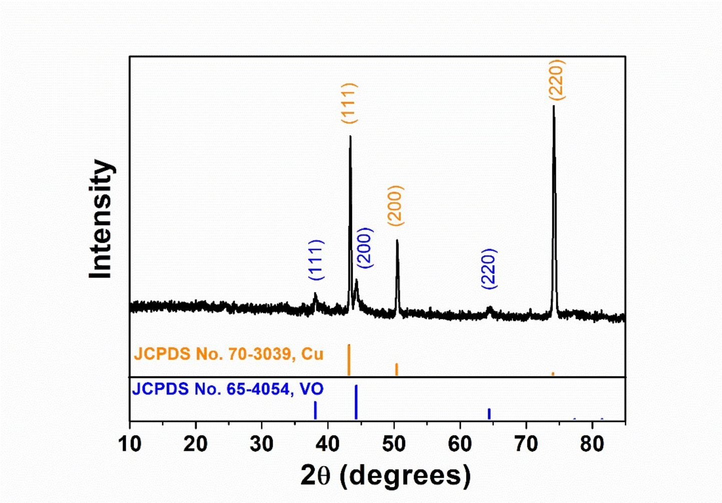

Fig. S7. Ex-situ XRD pattern of the VNC electrode after discharge, indicating the incomplete conversion reaction of vanadium oxides during discharge.

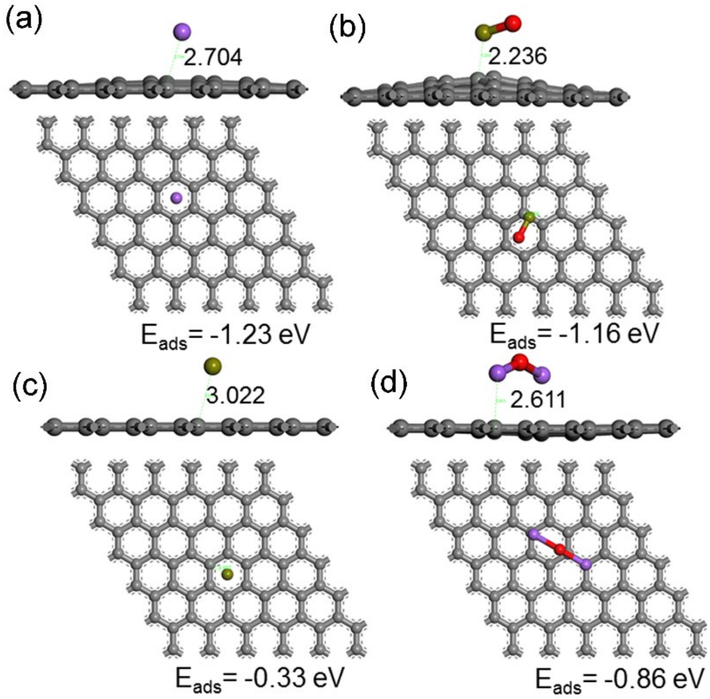

Fig. S8. Optimized geometry structures of Na (a), VO (b), V (c), and Na_2O (d) on pristine graphene basal plane. The corresponding adsorption energies (E_{ads}) and some representative bond lengths (all with unit of Å) are also shown.

Table S1. Electrochemical performance comparison of our sample with some representative anode materials for SIBs in recent literature.

Electrodes	Capacity (mAh g^{-1} at 0.1 A g^{-1})	Capacity (mAh g^{-1} at 0.2 A g^{-1})	Capacity (mAh g^{-1} at 0.5 A g^{-1})	Capacity (mAh g^{-1} at 1 A g^{-1})	Capacity (mAh g^{-1} at 2 A g^{-1})	Capacity (mAh g^{-1} at 5 A g^{-1})
Our work	**260**	**222**	**204.5**	**191.6**	**177.5**	**166.5**
porous V_2O_3/C[15]	247	202	176	164	149	NA
M-V_2O_3[27]	284	242	200	167	136	NA
V_2O_3/N-doped Carbon[26]	240	233	215	185	170	165 (3 A g^{-1})
VO_2/MX-1[30]	297	278	265 (0.4 A g^{-1})	242 (0.8 A g^{-1})	206 (1.6 A g^{-1})	NA
V_2O_3/NG[17]	193	171	150	130	115	NA
HCF-V_2O_5[31]	190	146	112	77	NA	NA
TiO_2@NFG[6]	NA	205 (0.25 A g^{-1})	190	170	157	140
TiO_2/C HRTs[32]	NA	225.6	210.3	191.9	168.6	141
a-Ti_3C_2 MNRs[33]	108	93	85 (0.3 A g^{-1})	NA	NA	NA
Amorphous Carbon[34]	250 (0.06 A g-	205 (0.3 A g^{-1})	138 (1.2 A g^{-1})	100 (2.4 A g^{-1})	81 (4.8 A g^{-1})	NA

	^{1})					
1D CNF[35]	NA	272	221	183	145 (2.5 A g^{-1})	117

NA: not available

Table S2. Capacity retention comparison of our sample with some representative anode materials for SIBs in recent literature.

Electrodes	Capacity (mAh g^{-1} at 1 A g^{-1} for 1 cycle)	Capacity (mAh g^{-1} at 1 A g^{-1} for 1000 cycles)	Capacity retention rate(%)	Refs
Our work	**214**	**152**	**71**	**This work**
porous V_2O_3/C	181 (2 A g^{-1})	133 (2 A g^{-1} for 1000 cycles)	73.5	15
V_2O_3/N-doped carbon	180.9	134.5 (3000 cycles)	74.4	26
VO_2/MX-1	185.5	143.0 (200 cycles)	77.1	30
HCF-V_2O_5	368 (0.1 A g^{-1})	184 (0.1 A g^{-1} for 100 cycles)	50	31
a-Ti_3C_2 MNRs	75 (0.2A g^{-1})	50 (0.2 A g^{-1} for 500 cycles)	66.7	33
ReS_2/N-CNFs	350 (0.1 A g^{-1})	245 (0.1 A g^{-1} for 800 cycles)	70	38
TiO_2@C nanosheets	135.4 (5 A g^{-1})	92.9 (5 A g^{-1} for 4000 cycles)	68.6	37
N@S-	520	379	73	36

Carbon	(0.1 A g^{-1})	(0.1 A g^{-1} for 1000 cycles)