Electronic Supplementary Material (ESI) for Sustainable Energy & Fuels.

Supporting Information

Tiny amounts of fluorinated carbon nanotubes remove sodium dendrite for high-performance sodium–oxygen batteries

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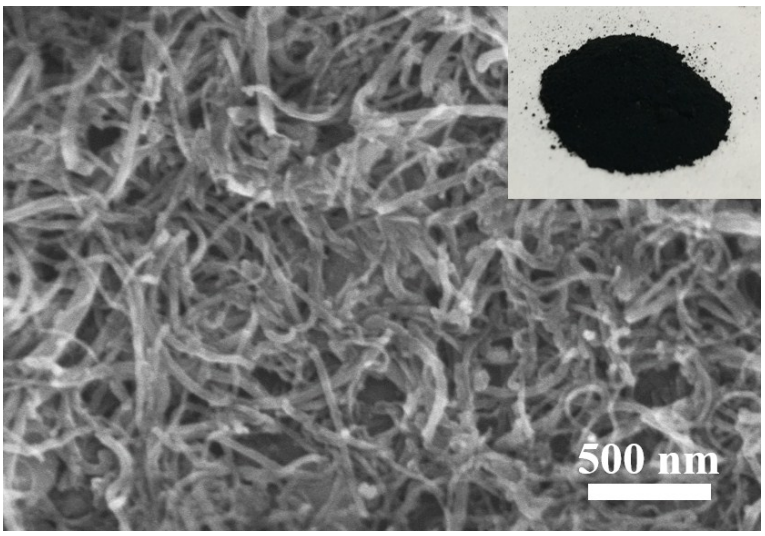

Fig. S1. SEM image of the commercial FCNTs.

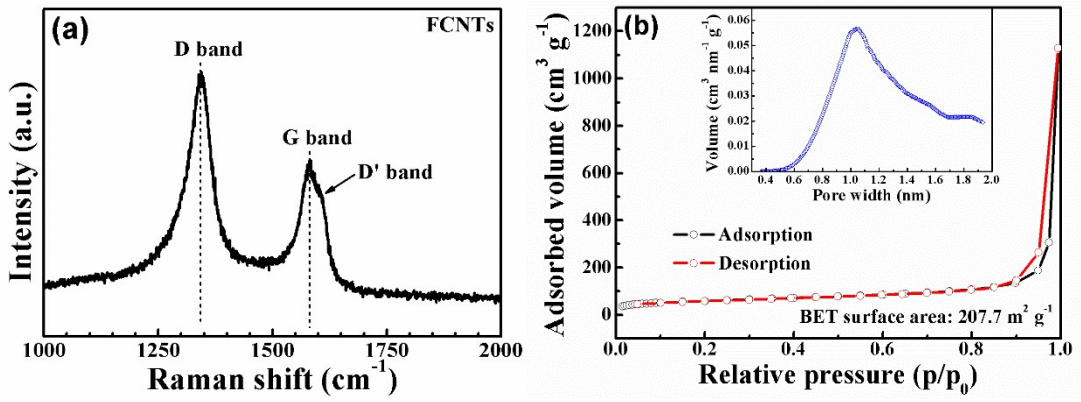

Fig. S2. (a) Raman spectrum of FCNTs, and (b) nitrogen adsorption/desorption isotherms and pore size distribution of FCNTs.

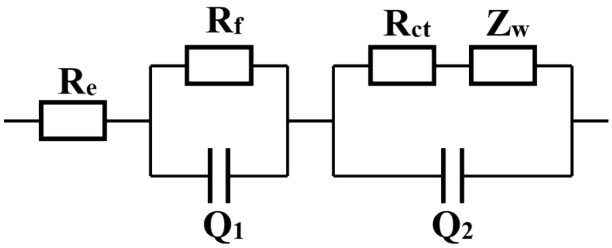

Fig. S3. Equivalent circuit for fitting of the Nyquist plots, where R_e represents ohm resistance of cell components, R_f and Q_1 correspond to surface film resistance and relaxation capacitance, R_{ct} and Q_2 represent the charge transfer resistance and double-layer capacitance, and Z_w is associated with the bulk diffusion of Na ions.

TableS1. Fitting results of the Nyquist plots in Fig. 3e and f.

Sample	$R_e(\Omega)$	$R_f(\Omega)$	$R_{ct}(\Omega)$	$R_{surface}(\Omega)$
bare Na, 5th cycle	25.5	781.6	376.1	1157.7
bare Na, 20th cycle	10.1	941.3	596.2	1537.5
bare Na, 50th cycle	13.7	991.2	636.9	1628.1
Na/FCNTs, 5th cycle	19.6	305.7	210.3	516.0
Na/FCNTs, 20th cycle	13.6	345.7	233.4	579.1
Na/FCNTs, 50th cycle	11.5	475.7	383.6	859.3

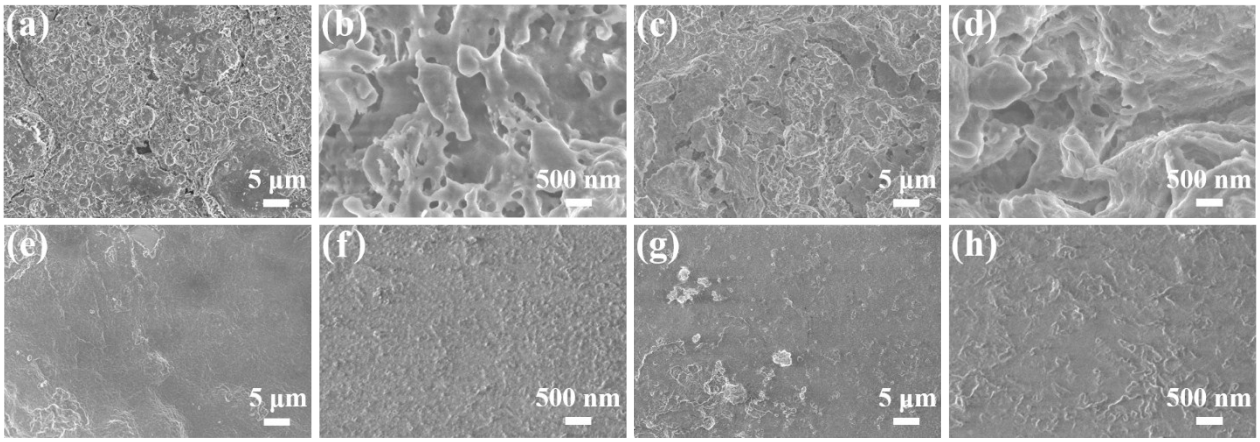

Fig. S4. SEM images of bare Na electrodes after (a, b) 30% and (c, d) 50% Na stripping, and SEM images of Na/FCNTs electrodes after (e, f) 30% and (g, h) 50% Na stripping at 1 mA cm^{-2}.

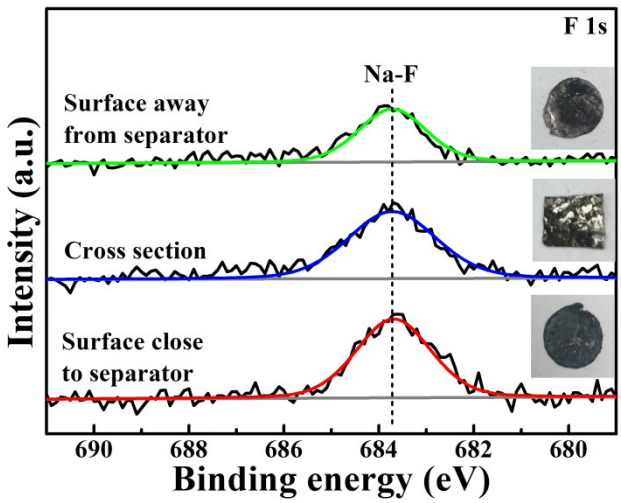

Fig. S5. F1s XPS spectra of the Na/FCNTs electrode surface close to separator, the cross section and the surface away from separator of Na/FCNTs electrode after 30% Na stripping at 1 mA cm^{-2}.

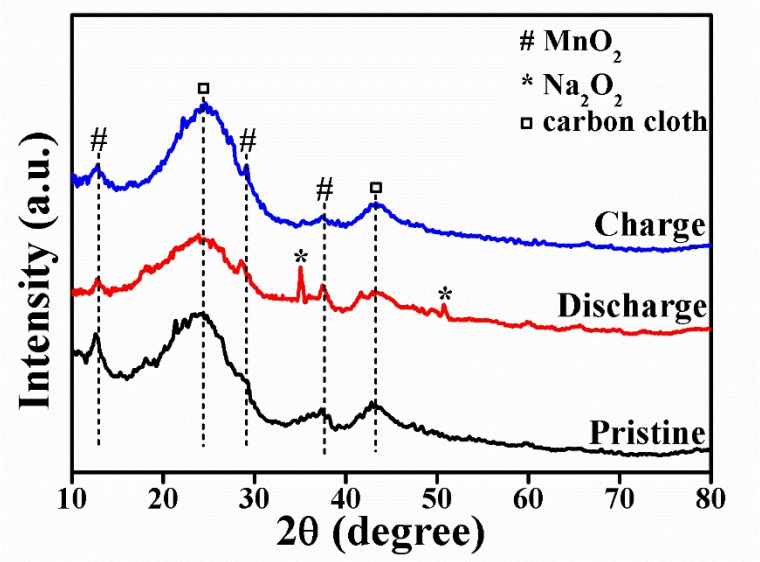

Fig. S6. XRD patterns of cathodes of the Na–O_2 cells at different states with Na/FCNTs anode.

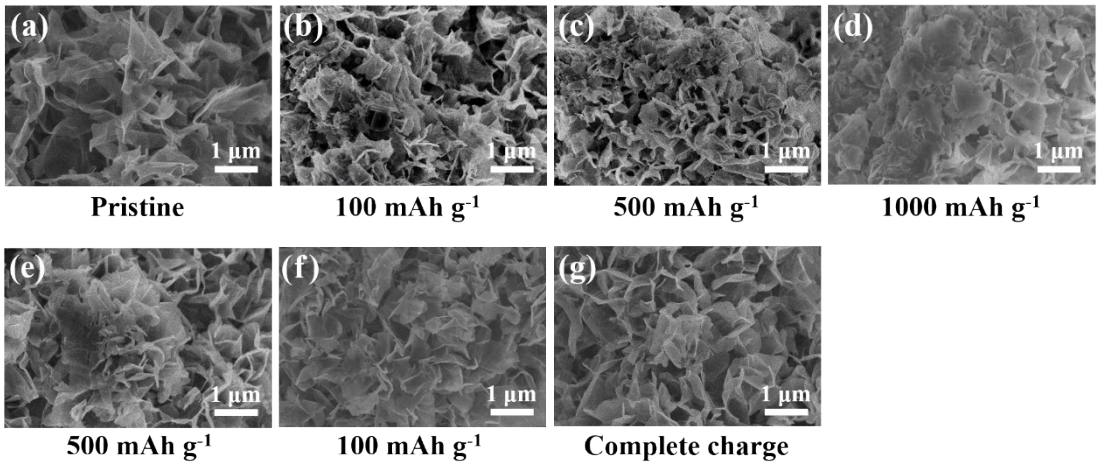

Fig. S7. SEM images of cathodes of the Na–O_2 cells at different states with Na/FCNTs anode: (a) pristine state, (b) 100 mAh g^{-1} and (c) 500 mAh g^{-1} and (d) 1000 mAh g^{-1} discharge capacities, (e) 1000 mAh g^{-1} discharge capacity and 500 mAh g^{-1} charge capacity, (f) 1000 mAh g^{-1} discharge capacity and 900 mAh g^{-1} charge capacity, and (g) complete charge state (1000 mAh g^{-1} discharge capacity and 1000 mAh g^{-1} charge capacity).

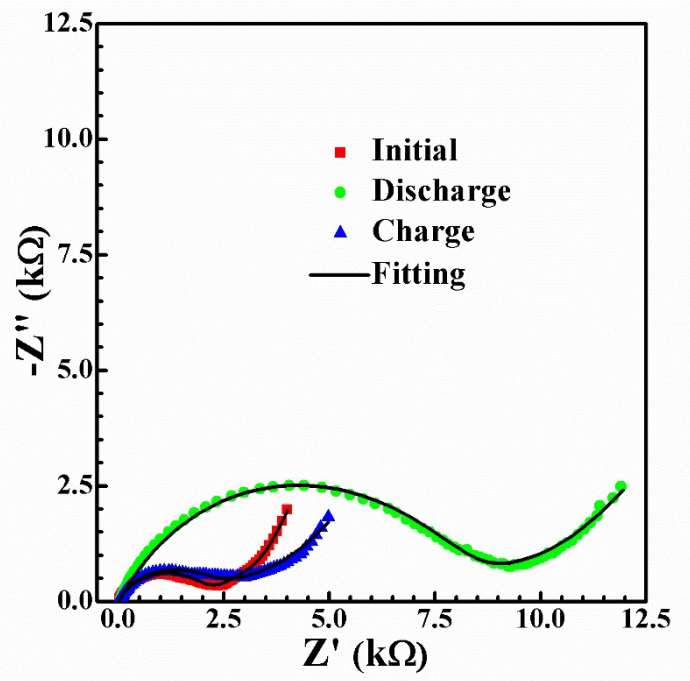

Fig. S8. Nyquist plots of the Na–O_2 cells with Na/FCNTs anode at different states.

TableS 2. Fitting results of the Nyquist plots in Fig. S8.

Sample	$R_e(\Omega)$	$R_f(\Omega)$	Q_1		$R_{ct}(\Omega)$	Q_2	
			Y	n		Y	n
Initial	16.4	256.6	7.9×10^{-6}	0.76	1804.5	7.5×10^{-6}	0.68
Discharge	25.6	274.1	6.0×10^{-6}	0.91	7703.2	1.2×10^{-6}	0.68
Charge	11.5	269.4	8.0×10^{-6}	0.80	1928.4	8.1×10^{-6}	0.64

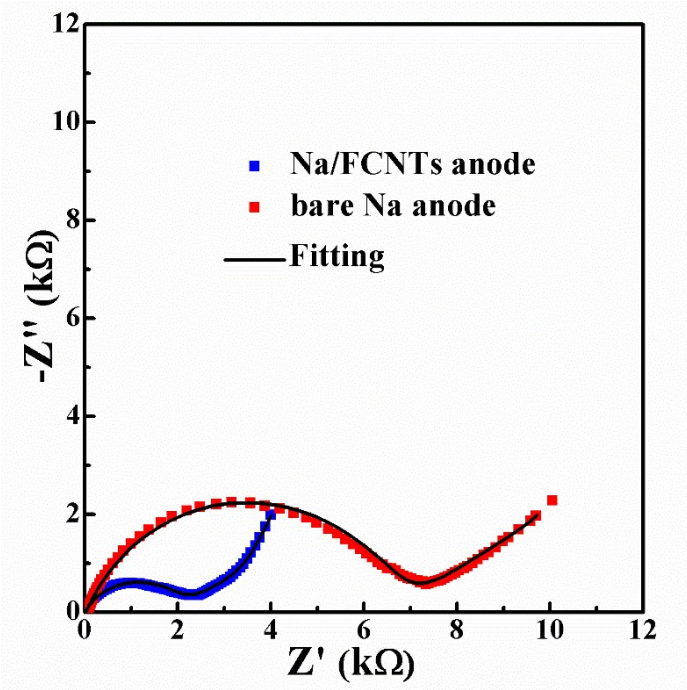

Fig. S9. Nyquist plots of the Na–O_2 cells with bare Na and Na/FCNTs anodes.

Table S3. Fitting results of the Nyquist plots in Fig. S9.

Sample	$R_e(\Omega)$	$R_f(\Omega)$	Q_1		$R_{ct}(\Omega)$	Q_2	
			Y	n		Y	n
Na/FCNTs	16.4	256.6	7.9×10^{-6}	0.76	1804.5	7.5×10^{-6}	0.68
bare Na	29.2	301.5	8.1×10^{-6}	0.89	6420.3	1.2×10^{-6}	0.73

Table S4. Comparison of electrochemical performance of Na–O_2 cells with different catalysts.

Catalyst	Anode	Current density	Specific capacity	Cycle number	Reference
δ-MnO_2	**Na/FCNTs**	**400 mA g^{-1} (0.16 mA cm^{-2})**	**1000 mAh g^{-1} (0.4 mAh cm^{-2})**	**112**	**This work**
$NiCo_2O_4$/Ni	Na foil	50mA g^{-1}	401 mAh g^{-1}	10th	[1]
Pd/ZnO/C	Na foil	33 mA g^{-1}	0.15 mAh cm^{-2}	15	[2]
CNT/Co_3O_4	Na foil	300 mA g^{-1}	300 mAh g^{-1}	21	[3]
$CaMnO_3$/C	Na foil	200mA g^{-1}	1000mAh g^{-1}	80	[4]
m-Ru-B-rGO	Na foil	0.05 mA cm^{-2}	0.5 mAh cm^{-2}	100	[5]
CNT/Ru	Na foil	0.191 mA cm^{-2}	0.38 mAh cm^{-2}	110	[6]
C@$NiCo_2O_4$	Na foil	100 mA g^{-1}	800 mAh g^{-1}	120	[7]
$MnCo_2O_4$/C	Na foil	0.05 mA cm^{-2}	1000 mAh g^{-1}	130	[8]
h-Co_3O_4@$MnCo_2O_{4.5}$ Ns	Na foil	100 mA g^{-1}	1000 mAh g^{-1}	135	[9]

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Information for videos

Video-1 Dynamic changes of the Na/FCNTs electrode at 2 mA cm^{-2}.

Video-2 Dynamic changes of the bare Na electrode at 2 mA cm^{-2}.