Supporting information

Figure S1.

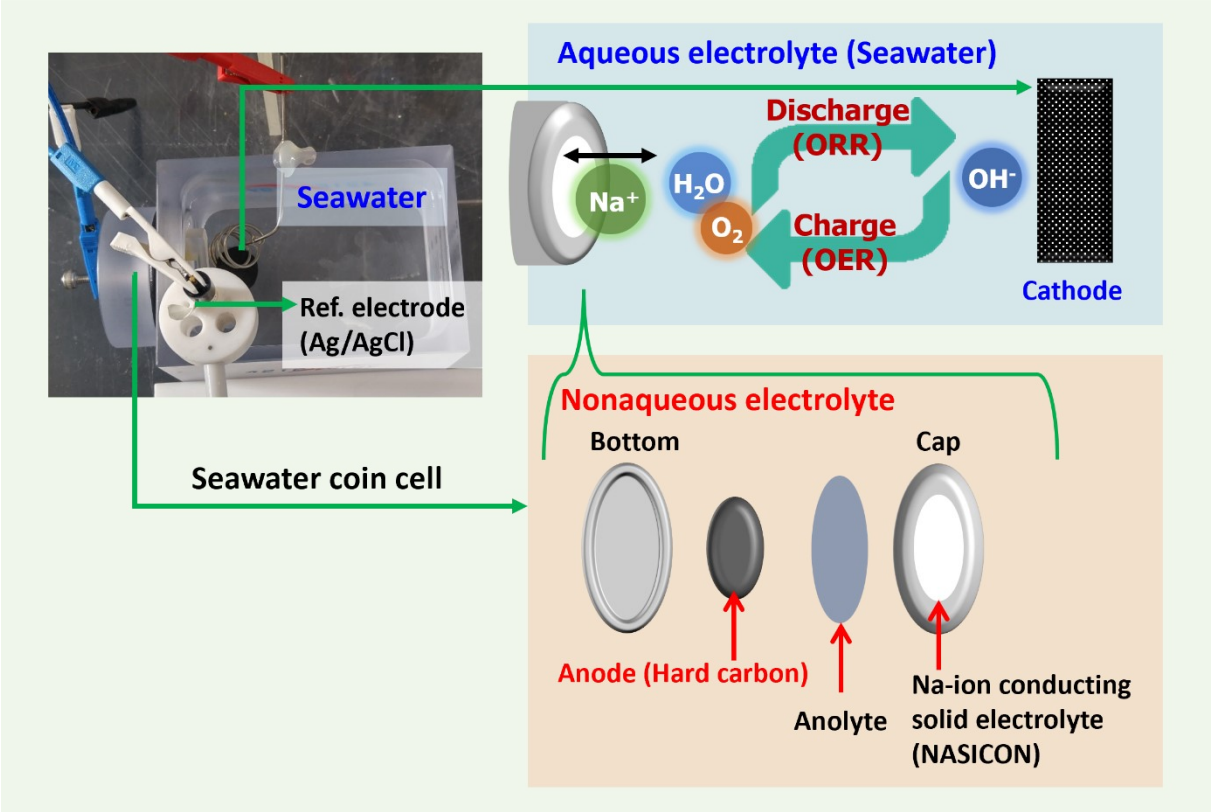

Figure S1. Schematic illustration of seawater cell (coin cell)

Figure S2.

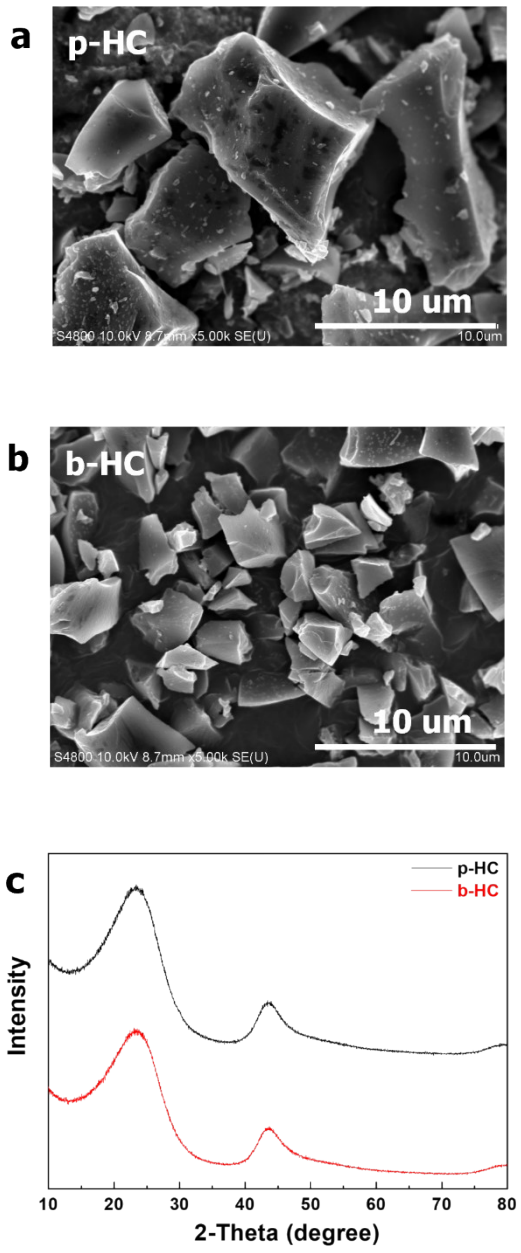

Figure S2. Morphology of **a)** pristine hard carbon and **b)** ball-milled hard carbon particles. **c)** XRD patterns of hard carbons

Figure S3.

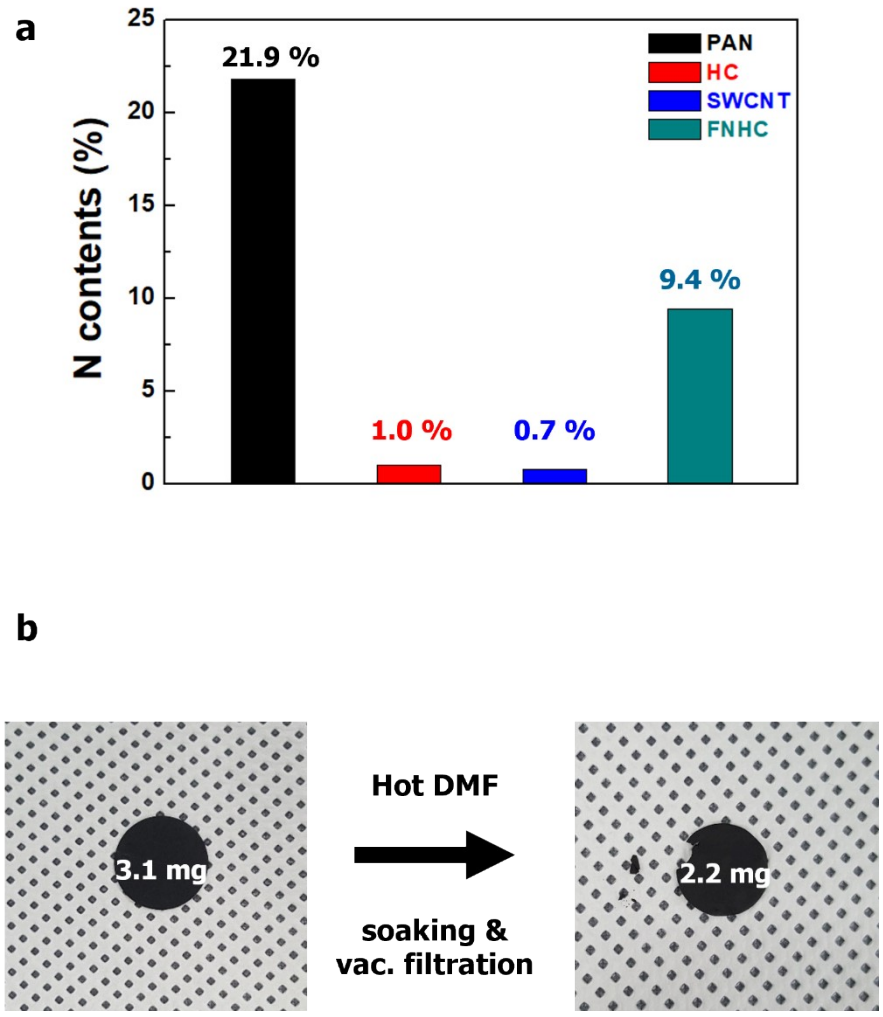

Figure S3. Composition ratio analysis of FNHC anode. **a)** XPS atomic weight integral of FNHC anode. **b)** Polymer etching test of FNHC anode.

Figure S4.

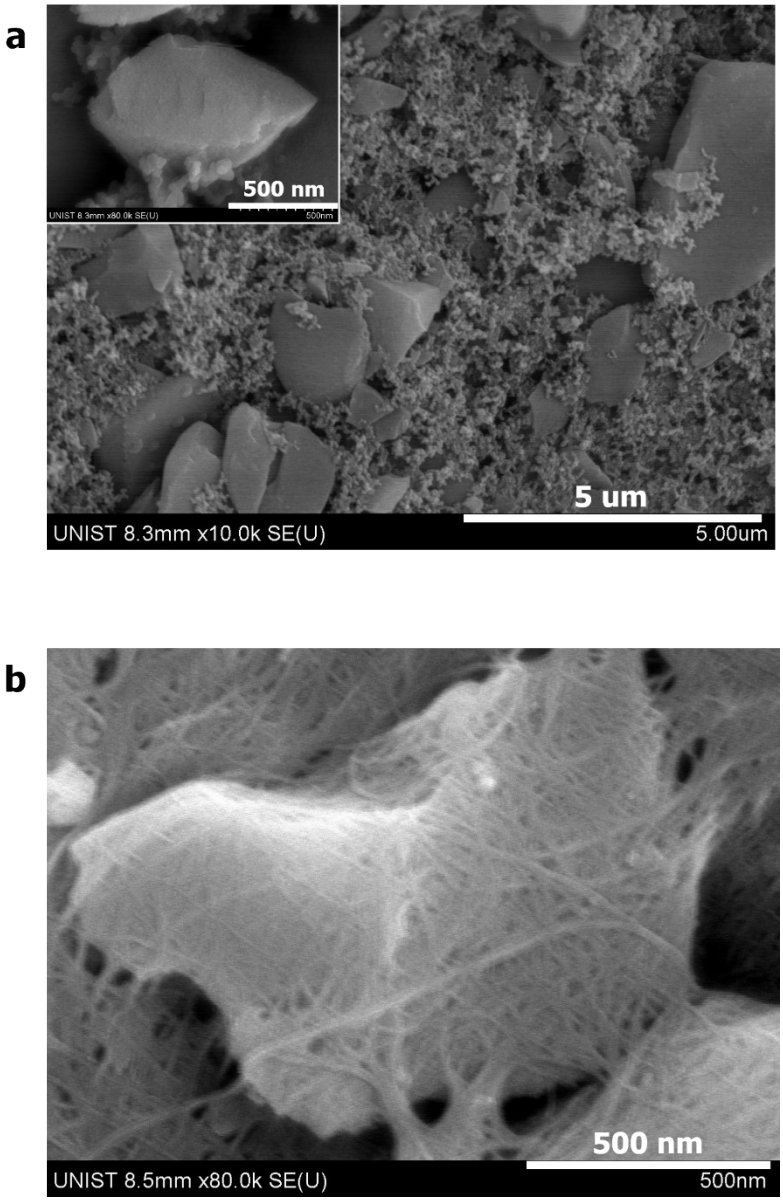

Figure S4. Morphology of **a)** Conv. HC anode. **b)** FNHC anode.

Figure S5.

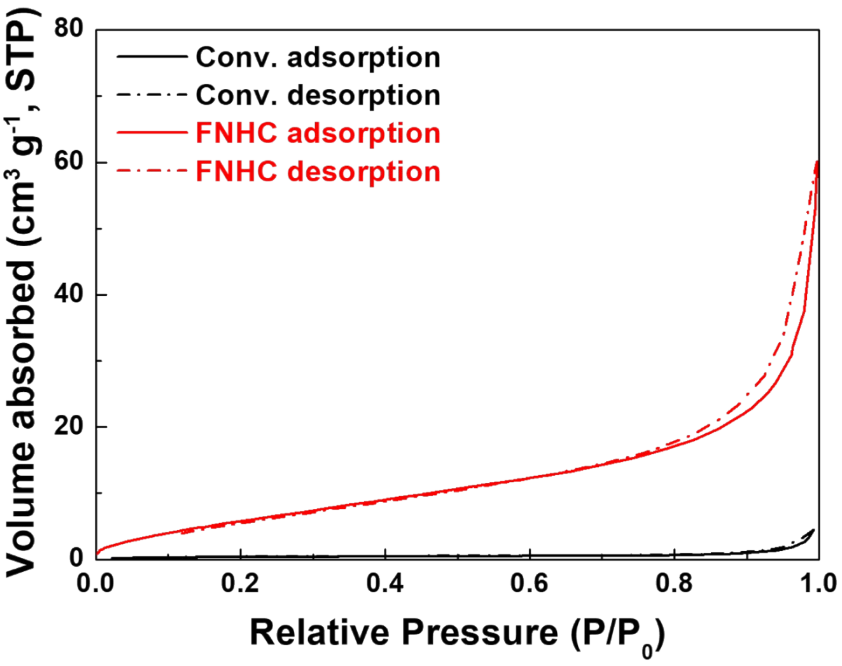

Figure S5. N_2 adsorption-desorption isotherm of anodes.

Figure S6.

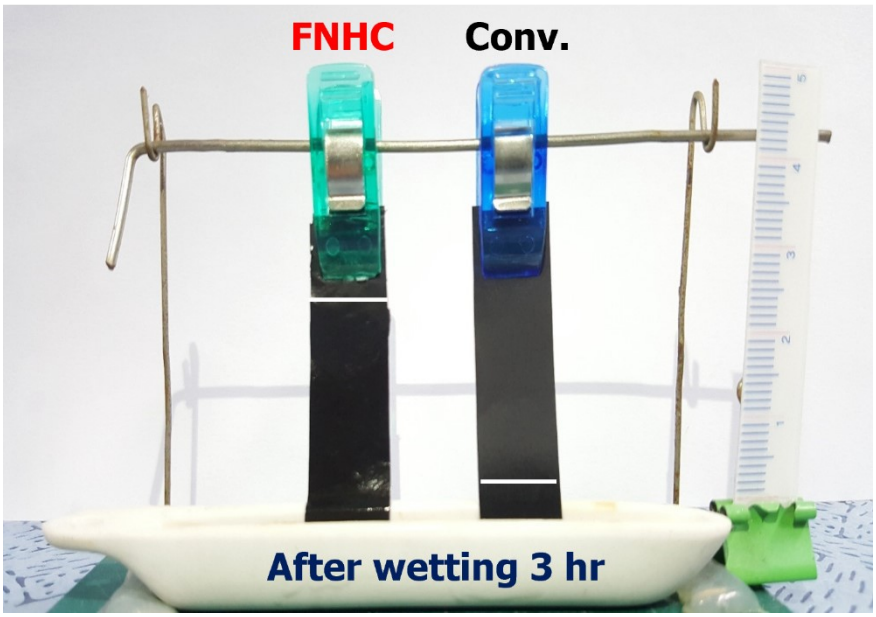

Figure S6. Electrolyte wettability of anodes.

Figure S7.

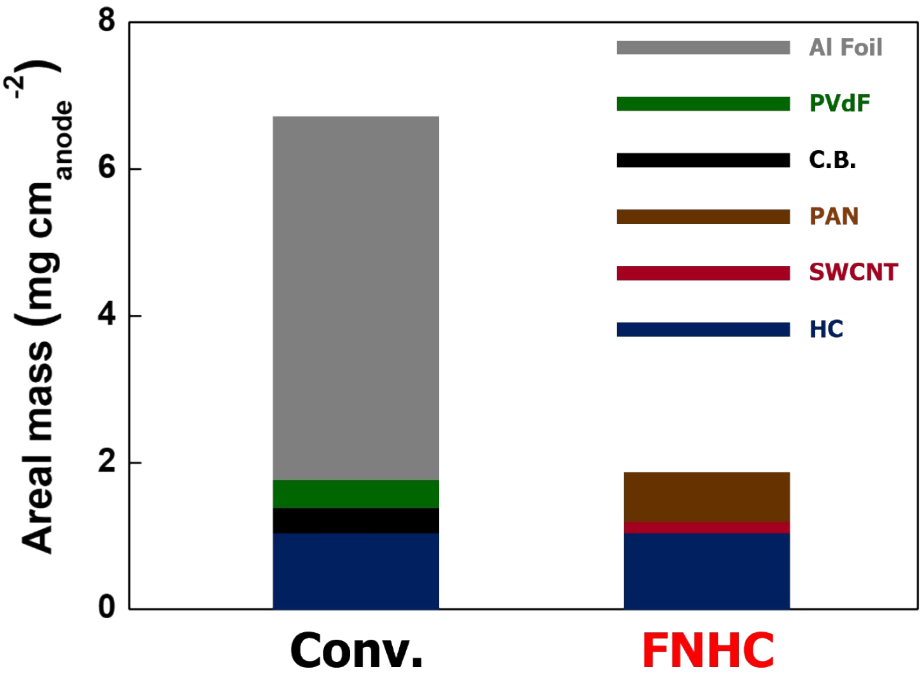

Figure S7. Areal mass of anodes.

Figure S8.

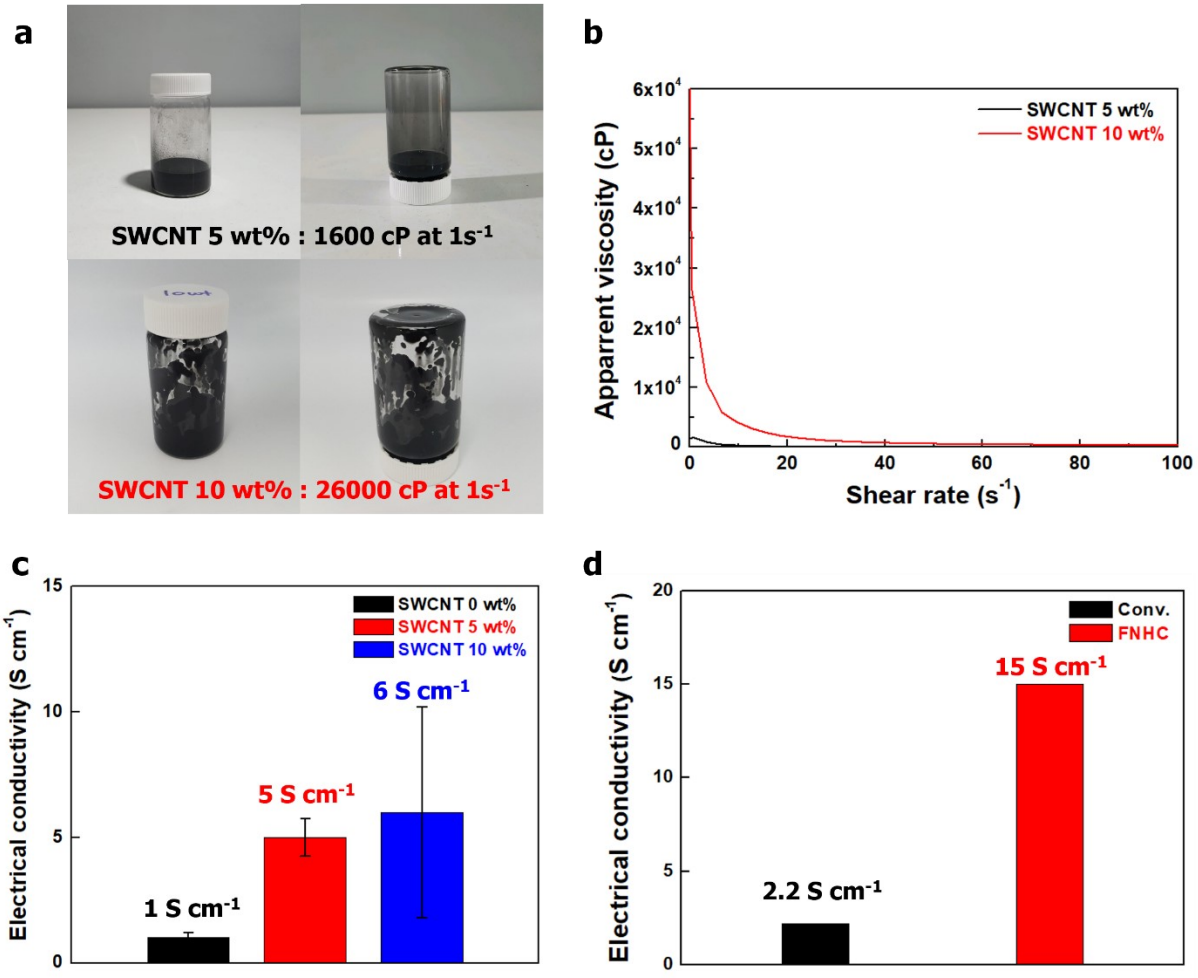

Figure S8. a) Digital camera images of anode suspension along SWCNTs contents. **b)** Apparent viscosity of anode suspension along SWCNTs contents. **c)** Electrical conductivity of anode suspension along SWCNTs contents. **d)** Electrical conductivity of anodes.

Figure S9.

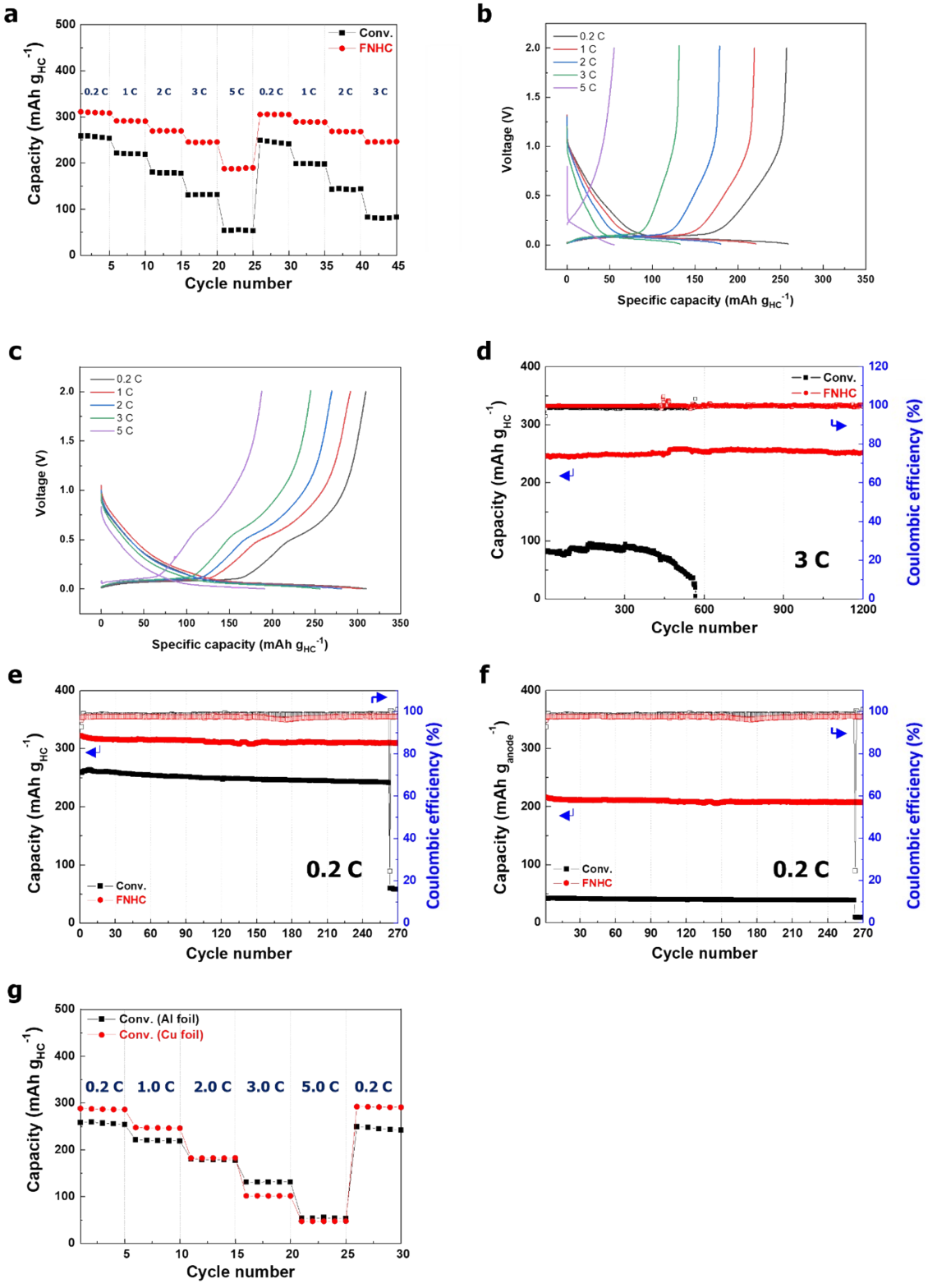
a
Capacity (mAh g_{HC}^{-1})
Cycle number
Conv.
FNHC
0.2 C
1 C
2 C
3 C
5 C
0.2 C
1 C
2 C
3 C
b
Voltage (V)
Specific capacity (mAh g_{HC}^{-1})
0.2 C
1 C
2 C
3 C
5 C
c
Voltage (V)
Specific capacity (mAh g_{HC}^{-1})
0.2 C
1 C
2 C
3 C
5 C
d
Capacity (mAh g_{HC}^{-1})
Coulombic efficiency (%)
Cycle number
Conv.
FNHC
3 C
e
Capacity (mAh g_{HC}^{-1})
Coulombic efficiency (%)
Cycle number
Conv.
FNHC
0.2 C
f
Capacity (mAh g_{anode}^{-1})
Coulombic efficiency (%)
Cycle number
Conv.
FNHC
0.2 C
g
Capacity (mAh g_{HC}^{-1})
Cycle number
Conv. (Al foil)
Conv. (Cu foil)
0.2 C
1.0 C
2.0 C
3.0 C
5.0 C
0.2 C

Figure S9. Electrochemical performance of anode half cell. **a)** Rate capability of anodes (capacity is calculated on the basis of active material mass (mAh g_{HC}^{-1})). **b)** Voltage profiles of Conv. **c)** Voltage profiles of FNHC **d)** High current density (at 3.0 C) cyclability of anodes (based on active material mass, mAh g_{HC}^{-1})**. e)** Cyclability of anodes at 0.2 C (based on active material mass, mAh g_{HC}^{-1}). **f)** Cyclability of anodes at 0.2 C (based on total anode mass, mAh g_{anode}^{-1}). **g)** Rate capability of the Conv. anode using Cu foil and Al foil as the collectors.

Figure S10.

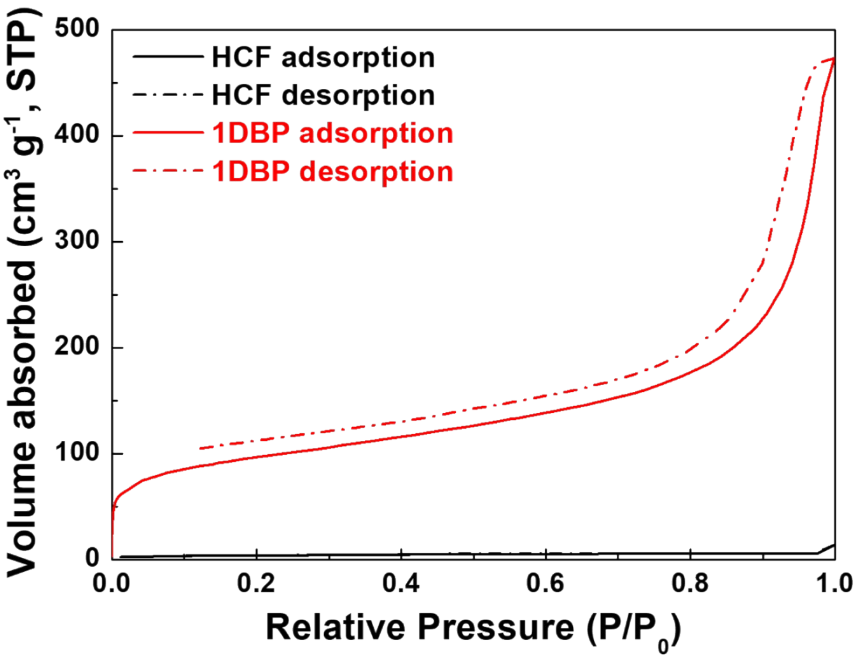

Figure S10. N_2 adsorption-desorption isotherm of cathodes.

Figure S11.

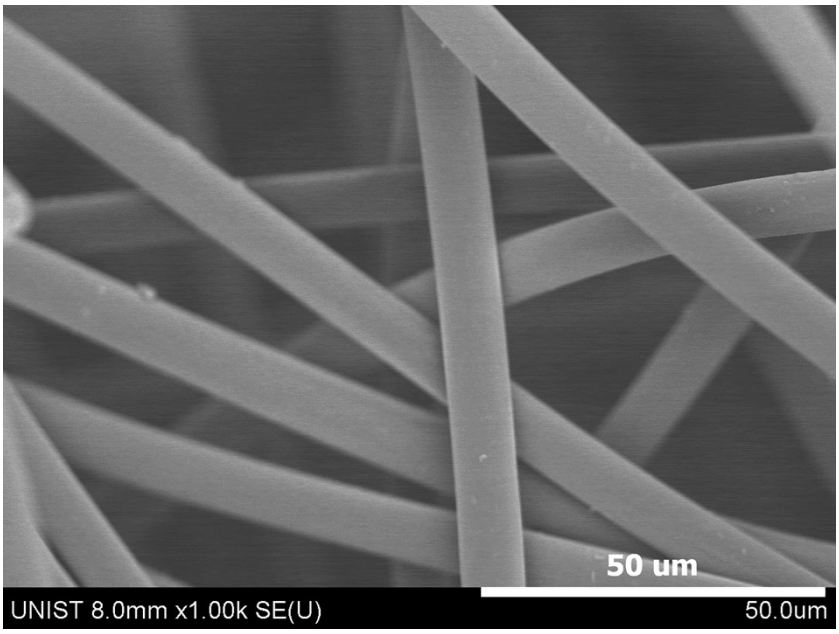

Figure S11. Morphology of conventional HCF.

Figure S12.

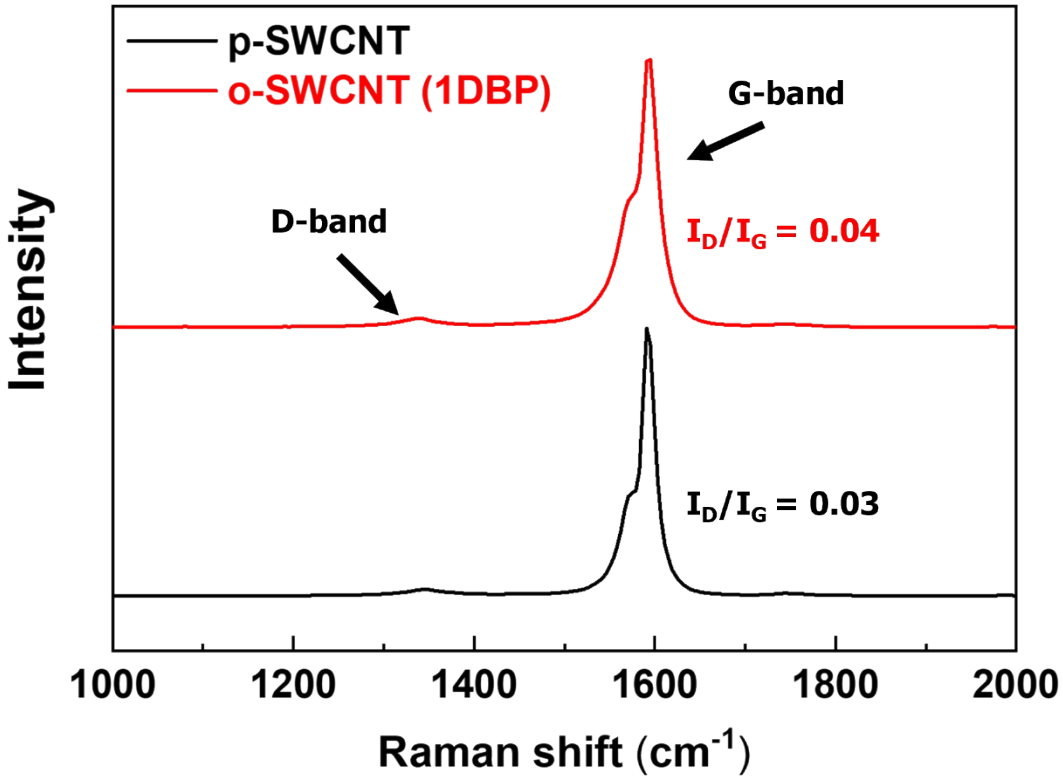

Figure S12. Confocal-Raman of SWCNTs.

Figure S13.

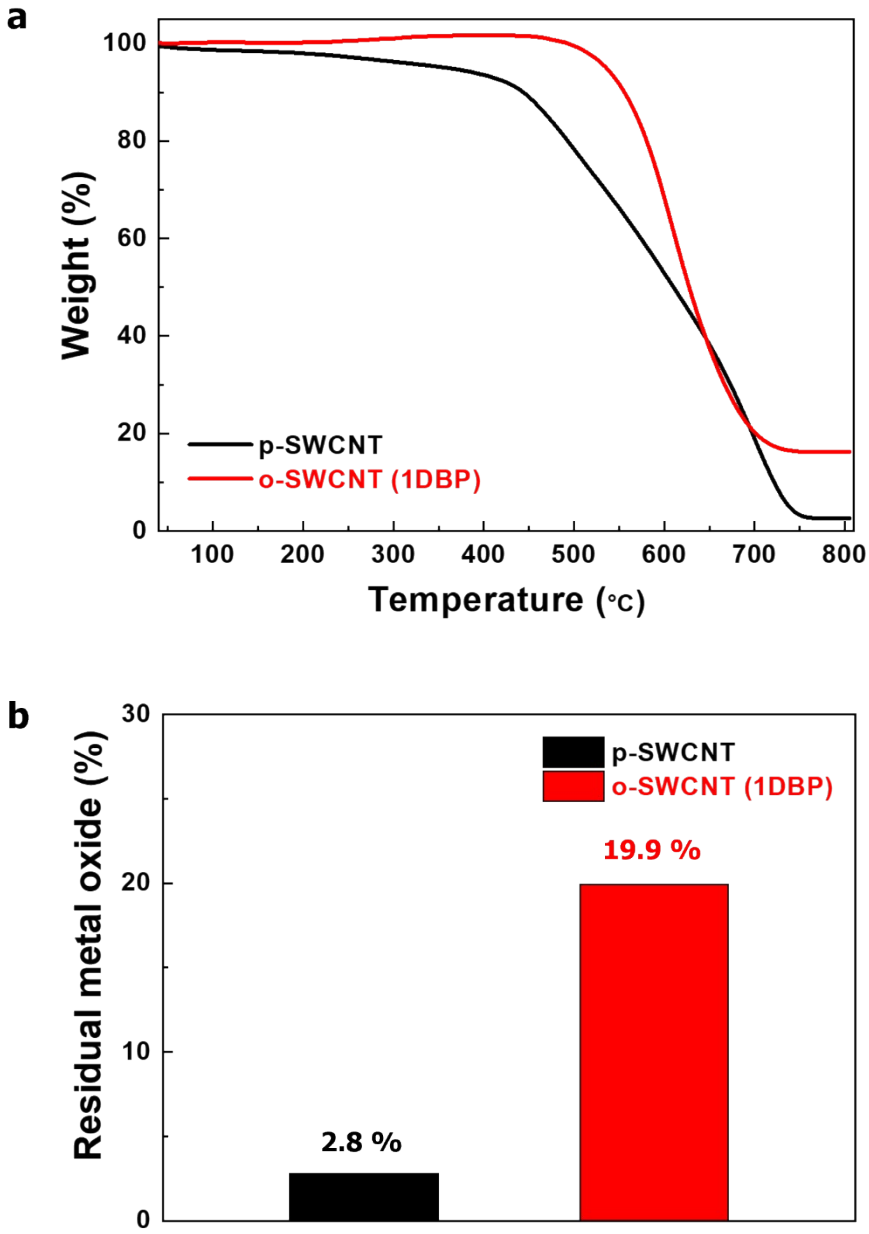

Figure S13. TGA profiles of SWCNTs.

Figure S14.

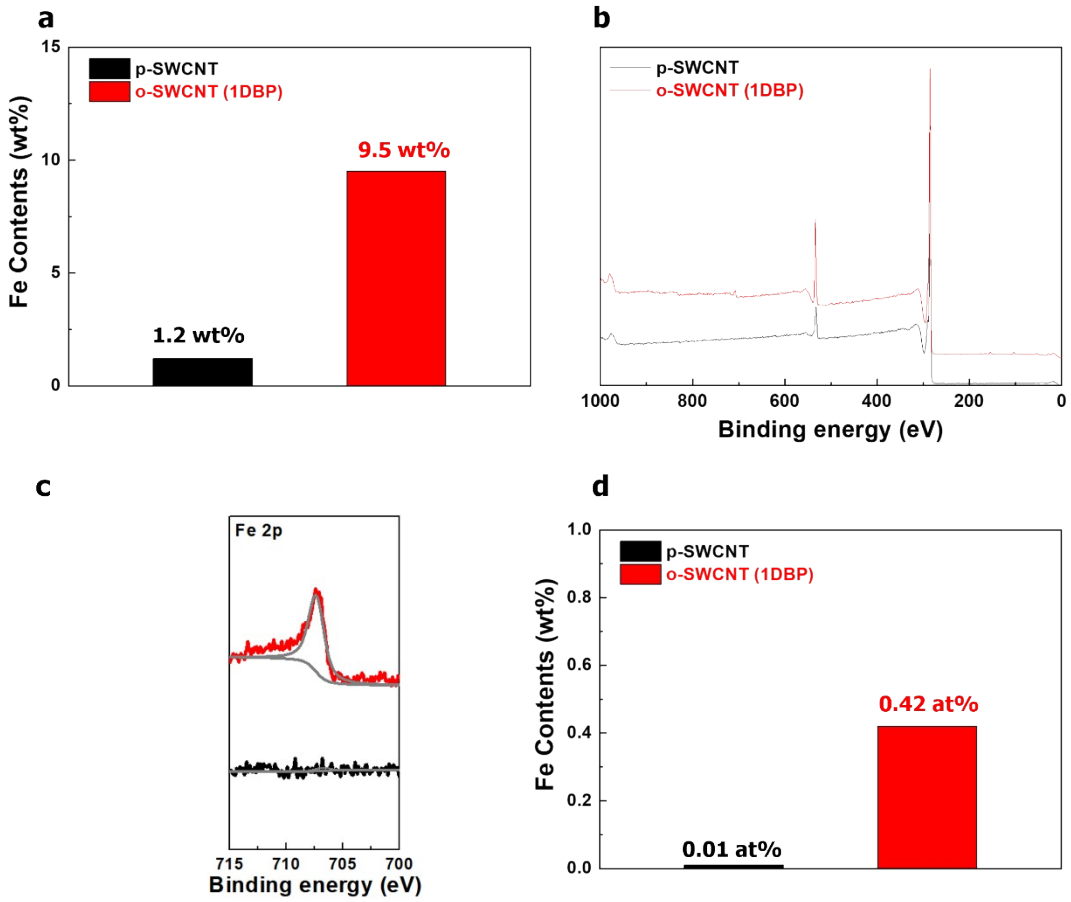

Figure S14. a) ICP-MS of SWCNTs. **b)** XPS full spectra of SWCNTs. **c)** XPS Fe 2p spectra of SWCNTs. **d)** XPS atomic weight integral of SWCNTs

Figure S15.

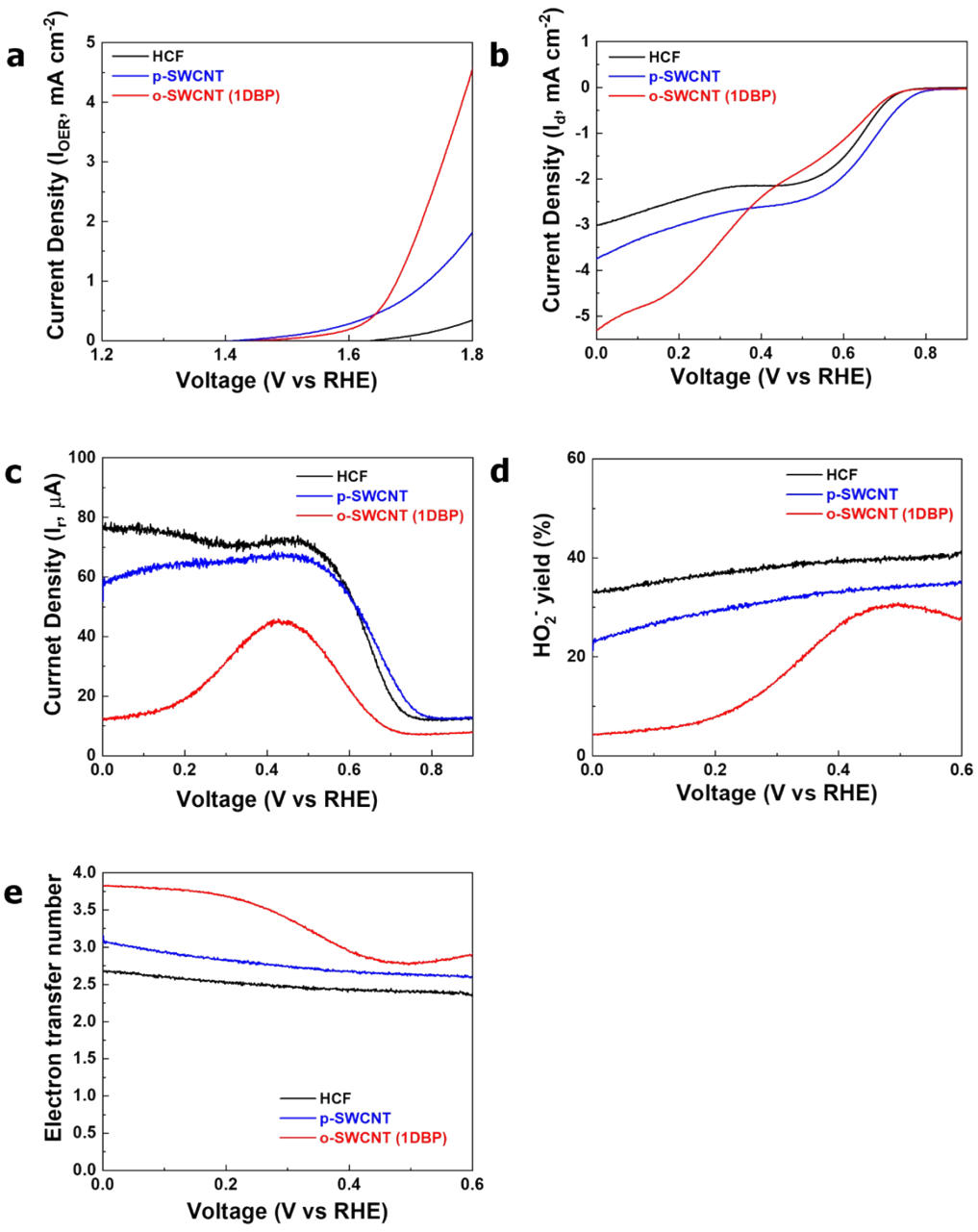

Figure S15. a) OER electrocatalytic activities (polarization curves) of the HCF, p-SWCNT, and o-SWCNT. **b-e)** ORR electrocatalytic activities of the HCF, p-SWCNT, and o-SWCNT. **b)** ORR polarization curves. **c**) Ring current density profiles. **d)** Peroxide yield (%). **e)** Electron transfer number (n).

Figure S16.

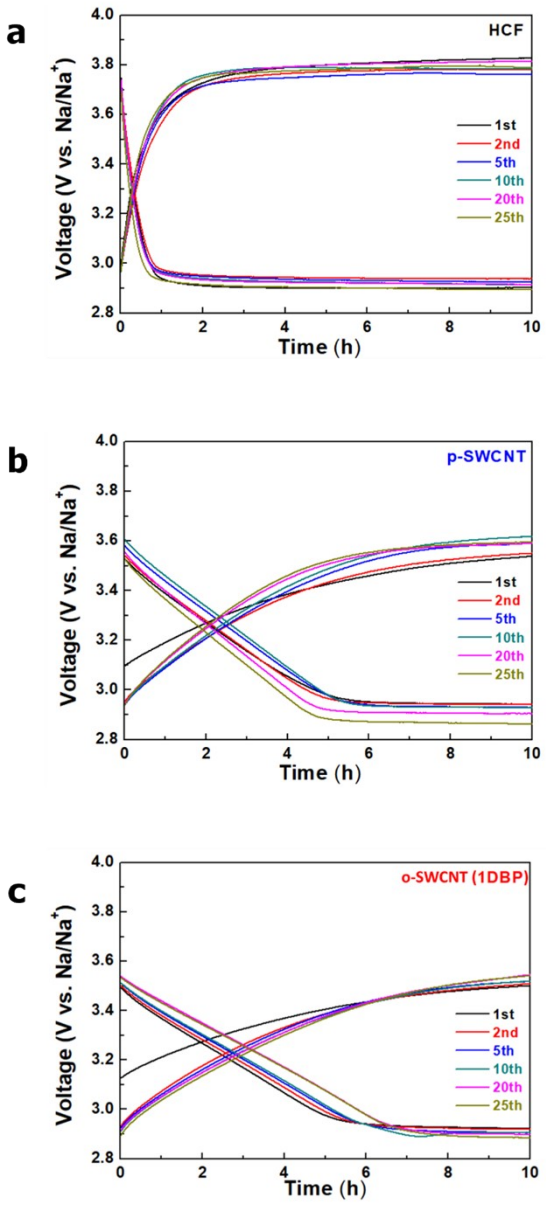

Figure S16. Electrochemical performance of seawater cathode half cells. **a)-c)** Charge/discharge voltage profiles of seawater cathode half cells with different cathodes at a charge/discharge current density of 0.01 mA cm^{-2} and each of 10 hours for 25 cycles, respectively. Voltage profiles of **a)** HCF, **b)** p-SWCNT, **c)** o-SWCNT (1DBP).

Table S1.

Catalyst	Voltage gap [V]	Current density [mA cm^{-2}]	Reference
Carbon paper	0.89	0.01	Ref.
Pt/C@carbon paper	0.68	0.01	Ref.
IrO_2@carbon paper	0.66	0.01	Ref.
MnO_2@carbon paper	0.73	0.01	Ref.
Vulcan X72	0.80	0.01	Ref.
1DBP bucky paper	**0.6**	**0.01**	**This Work**

Ref. S. T. Senthilkumar, S. O. Park, J. Kim, S. M. Hwang, S. K. Kwak, Y. Kim, *J. Mater. Chem. A* **2017**, *5*, 14174.

Table S1. Comparative analysis of the performance of 1DBP as a catalyst compared to commercial catalysts.

Figure S17.

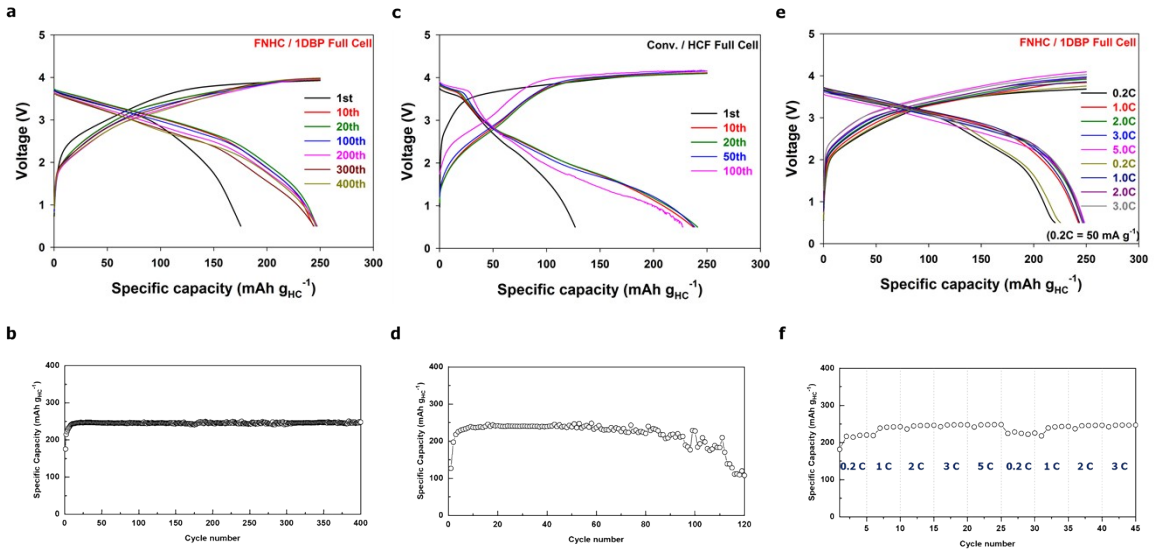

Figure S17. Electrochemical performance of seawater full-cells. **a-d)** Cycling performance of seawater full-cells with different anode/cathode combination, respectively (capacity is calculated on the basis of active material mass (mAh g_{HC}^{-1})). Voltage profiles of **a)** FNHC/1DBP and **c)** Conv./HCF. Cyclability of **b)** FNHC/HCF and **d)** Conv./1DBP. Voltage profiles **e)** and rate capability **f)** of FNHC/1DBP combination of seawater full-cells at different current densities from 0.2 to 5.0 C (based on active material mass, mAh g_{HC}^{-1}).

Table S2.

	Conv./HCF	**FNHC/1DBP**
Specific capacity [at 2.0 C-rate]	39.2 mAh g_{anode}^{-1}	**172.5 mAh g_{anode}^{-1}**
Energy efficiency [at 5.0 C-rate]	53.2%	**75.6%**
Cycle life	120 cycles	**> 400 cycles**
Specific energy density [at 2.0 C-rate]	573 Wh kg^{-1}	**693 Wh kg^{-1}**
Specific power density [at 5.0 C-rate]	2575 W kg^{-1}	**3341 W kg^{-1}**

Table S2. The electrochemical performance of the FNHC anode and 1DBP cathode, compared with the Conv. anode and HCF cathode