

Supporting Information

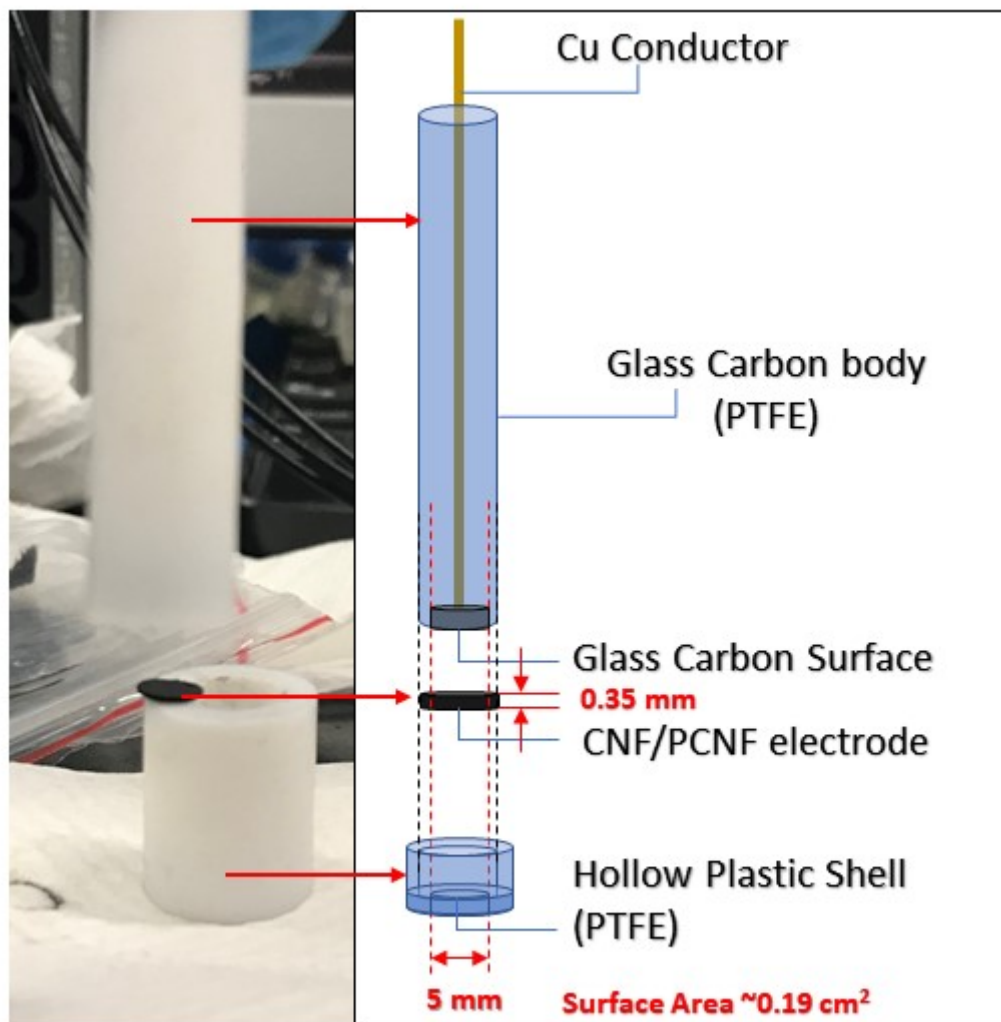


Fig. S1 Schematic illustration of CNF electrode assembled in a glass carbon working electrode.

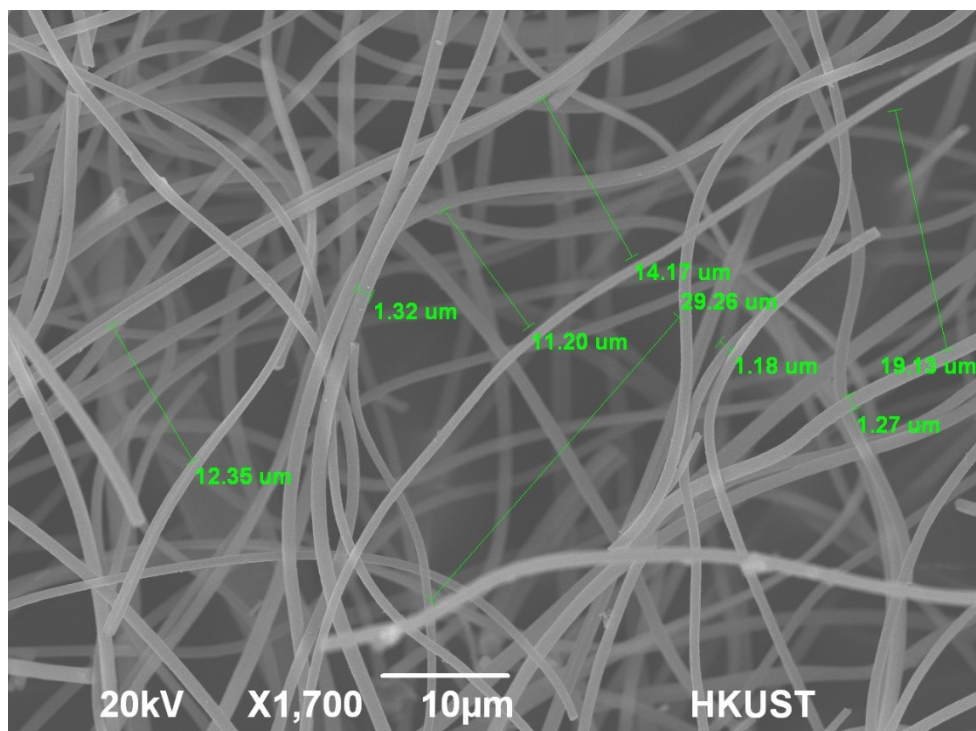


Fig. S2. Measurement of open voids between nanofibers in CNF-1100.

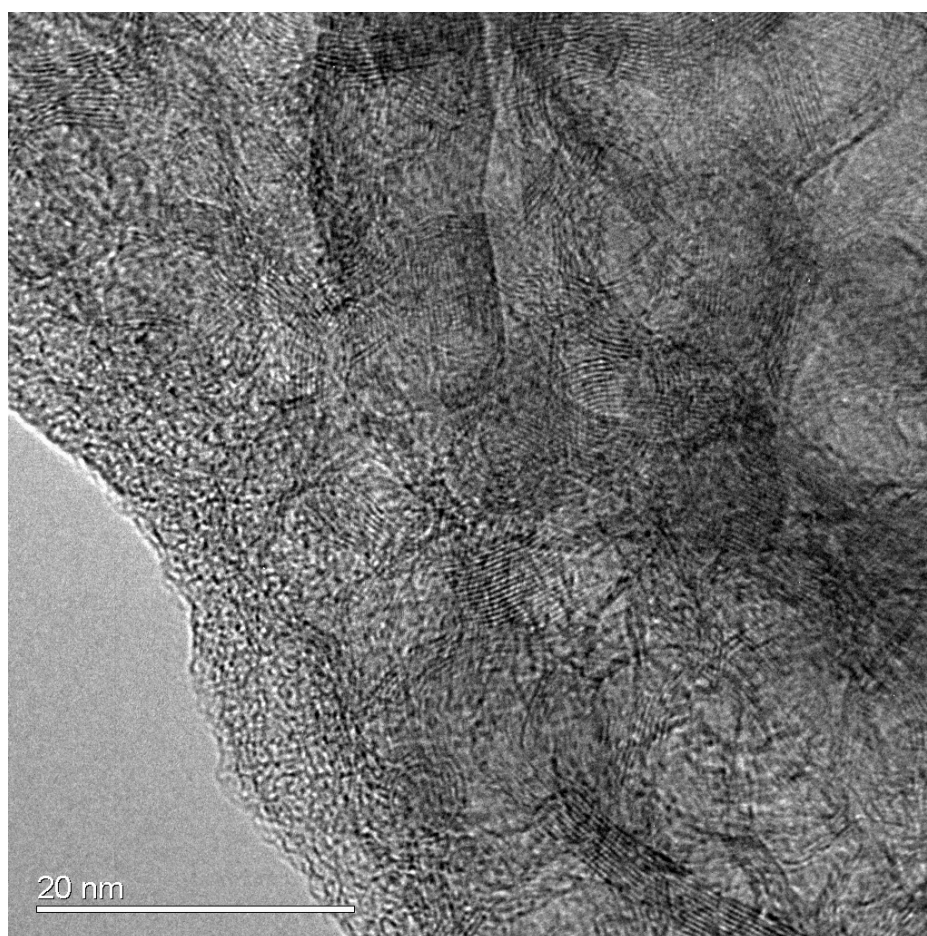


Fig. S3. HRTEM image of PCNF containing interconnected graphitic carbon layers.

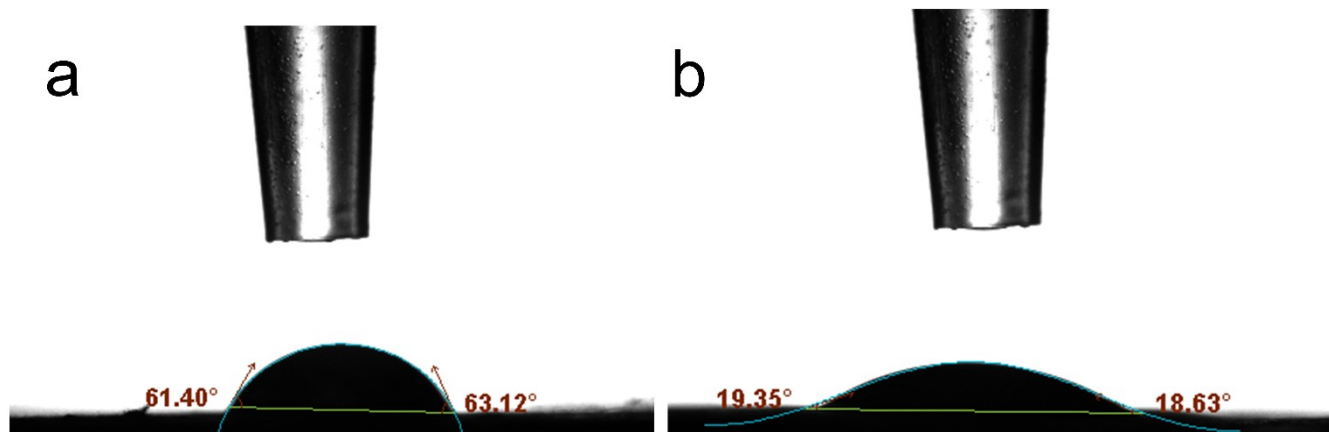


Fig. S4 Contact angles of 1 M V(IV) + 3 M H₂SO₄ electrolyte on a PCNF (a) before and (b) after HNO₃ treatment.

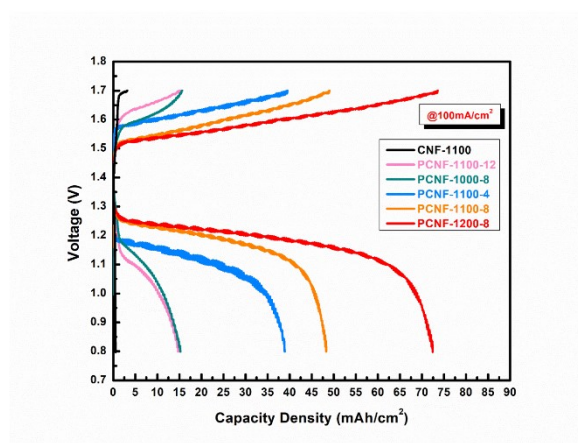


Fig. S5 Charge/discharge voltage-capacity density curves of different electrodes measured at a current density of 100 mA/cm².

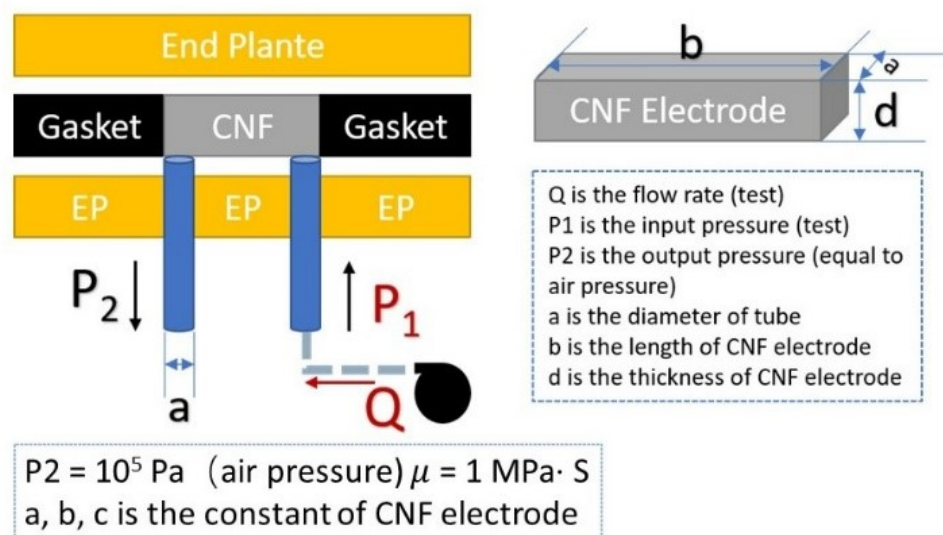
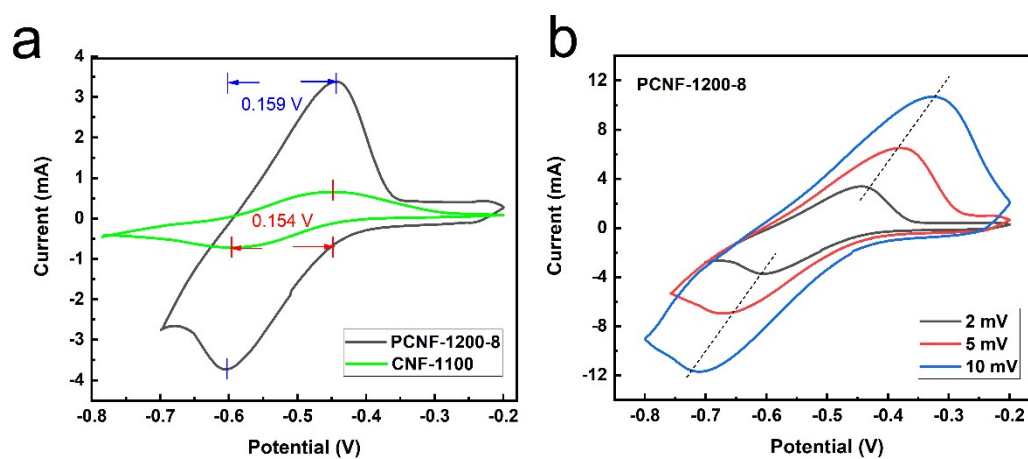


Fig. S6 Schematic illustration of permeability measurement device and test details

Fig. S7 CV profiles obtained in 0.1 M V(III) + 3 M H_2SO_4 (a) of the CNF-1100 and PCNF-1200-8 electrodes at 2 mV and (b) of the PCNF-1200-8 electrodes at different scan rates.

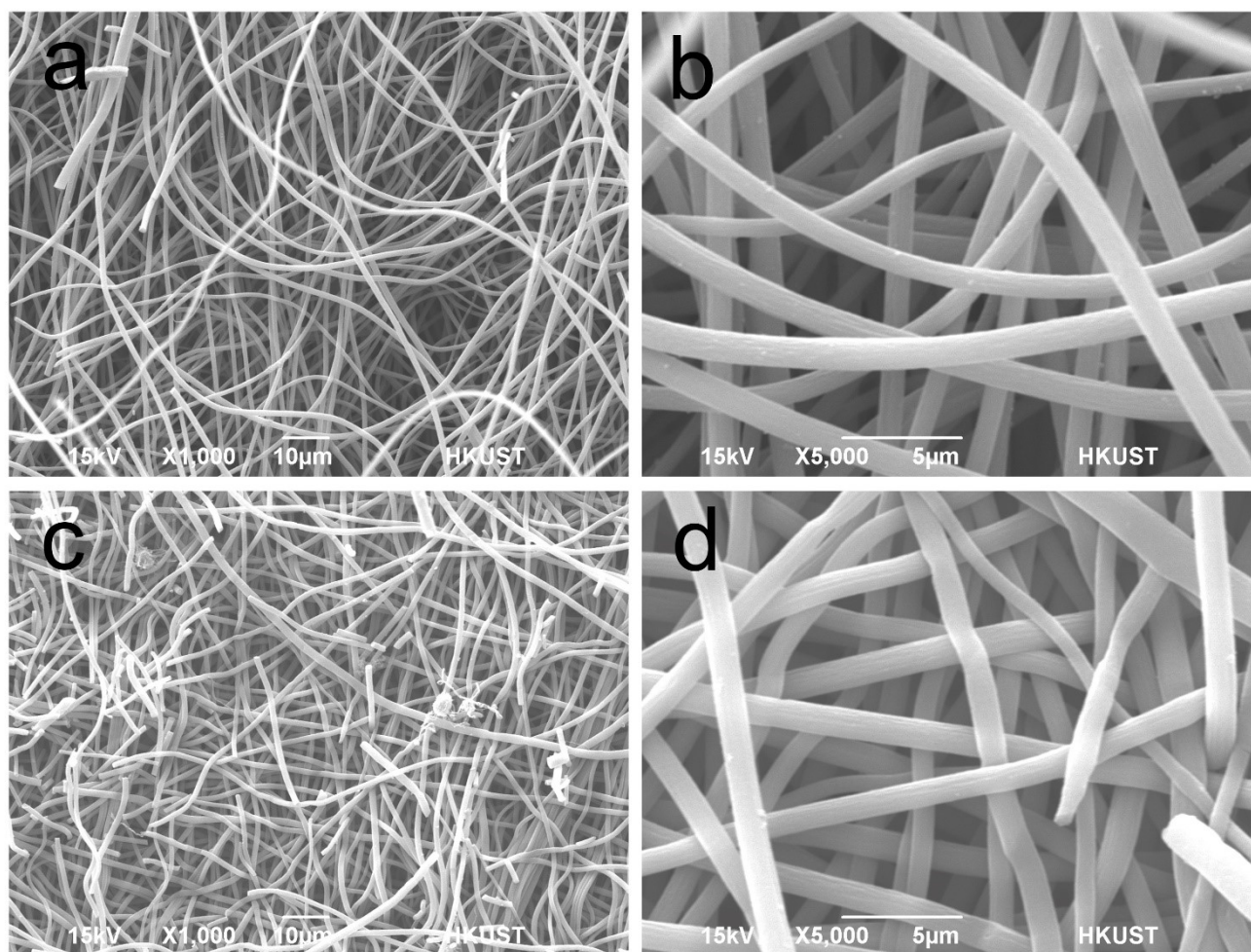


Fig. S8 SEM image of PCNF-1200-8: (a, b) before the assembly into batteries and (c, d) after 500 cycles in the VRFB full-cell test.

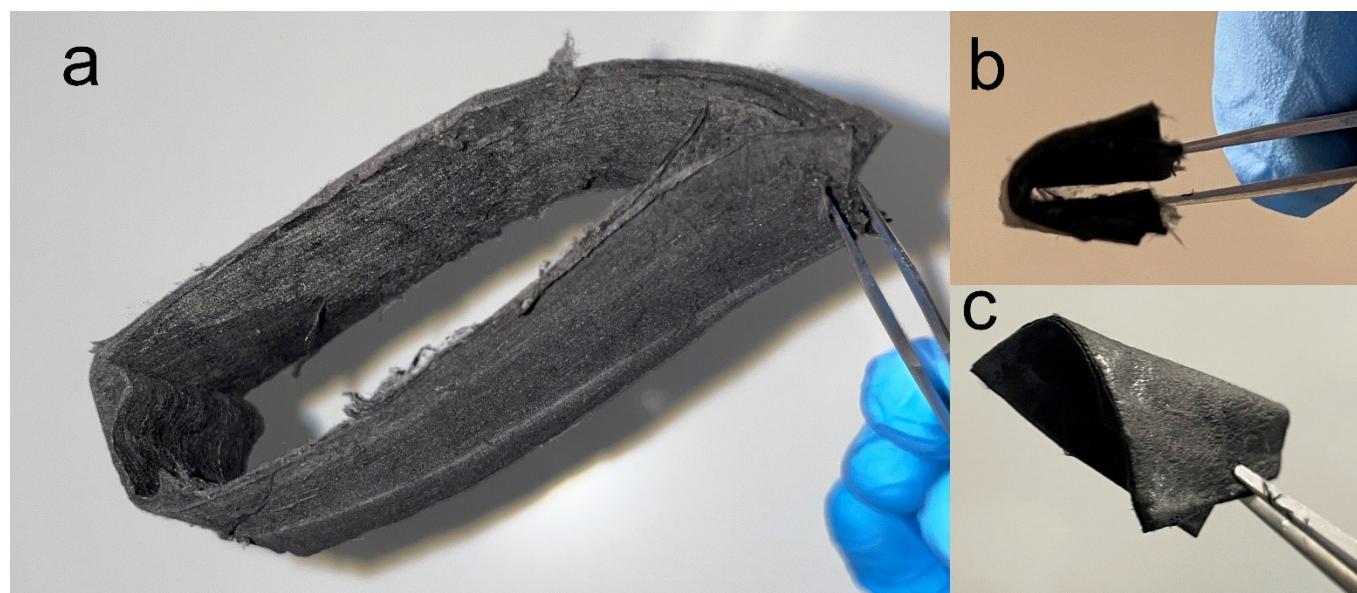


Fig. S9 Optical images of (a) bulk PCNF-1200-8 sample; (b) PCNF-1200-8 electrode before assembly into a battery; and (c) after 100 cycles in the VRFB full-cell test.

Table S1 Comparison of permeability, ΔP .

Materials	ΔP (kPa)	Q (ml/min)	K (m ²)	Darcy's law
PCNF	47	48.5	3.2*10 ⁻¹³	$Q = \frac{k * b * d}{u * a} (P1 - P2) = \frac{k * b * d}{u * a} * P$
GDL 39AA (commercial carbon paper)	230	1.8	1.5*10 ⁻¹²	

Table S2 Atomic and mass concentrations of PCNF-1200-8 determined by XPS analysis.

Elements	Fe 2p	O 1s	N 1s	C 1s
Atomic Concentration (%)	0.12	10.68	1.50	87.69
Mass concentration (%)	0.55	13.65	1.68	84.12

Table S3. Comparison of energy efficiencies between PCNF-1200-8 and commercial carbon electrodes taken from the literature.

Electrode materials	Current density (mA/cm ²)	Energy efficiency (%)	Ref.
PCNF-1200-8	80	82.5	Current study
	100	79.3	
	120	76.3	
	150	71.6	
Carbon felts (3.0 cm × 4.5 cm, Liaoning JinGu)	200	60	11
	360	55	13
	380	50	19
Commercial carbon felts (1.0 cm × 2.5 cm)	80	78	17
Commercial carbon felts (13.5 cm ²)	360	51	18