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

Electronic Supplementary Information

Binary $NiCoO_2$-modified graphite felt as an advanced positive electrode for the vanadium redox flow battery

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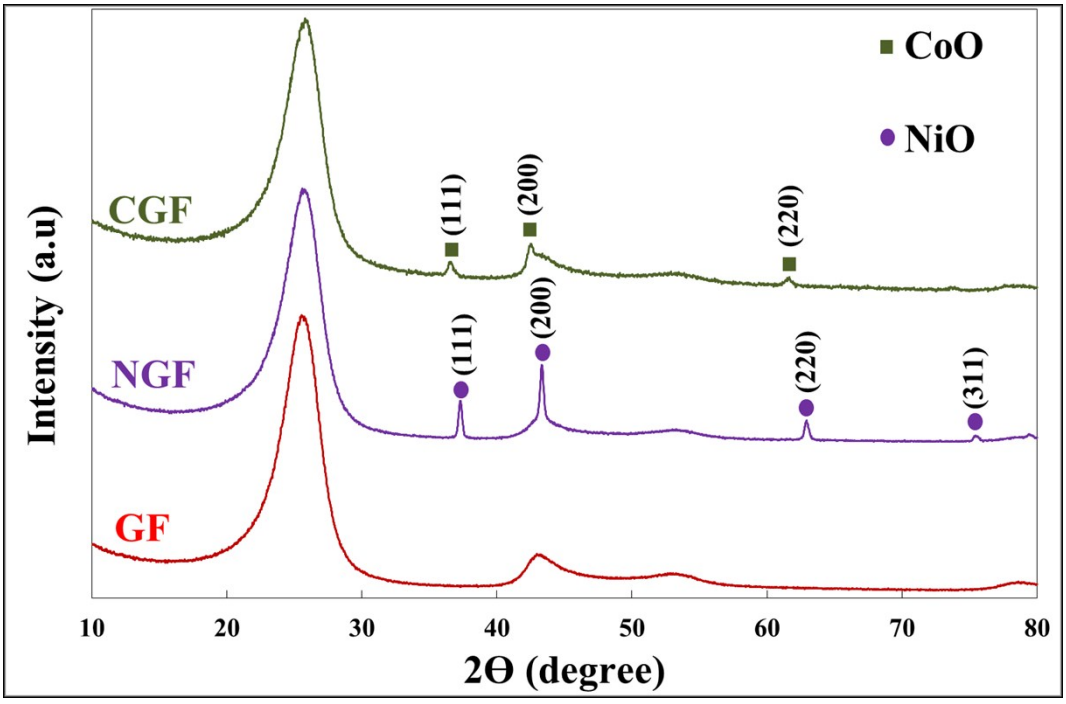


Fig. S1: XRD spectra of GF, NiO/GF and CoO/GF.

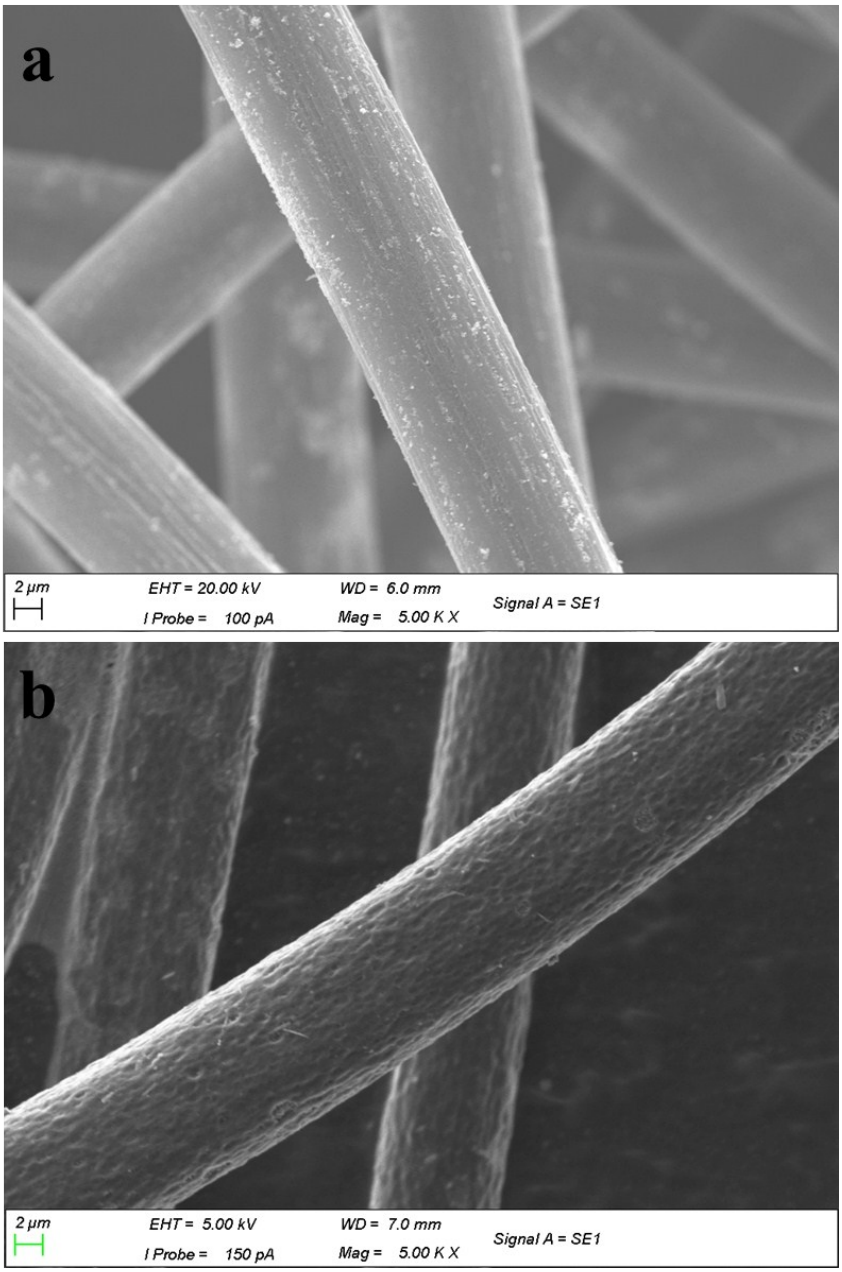
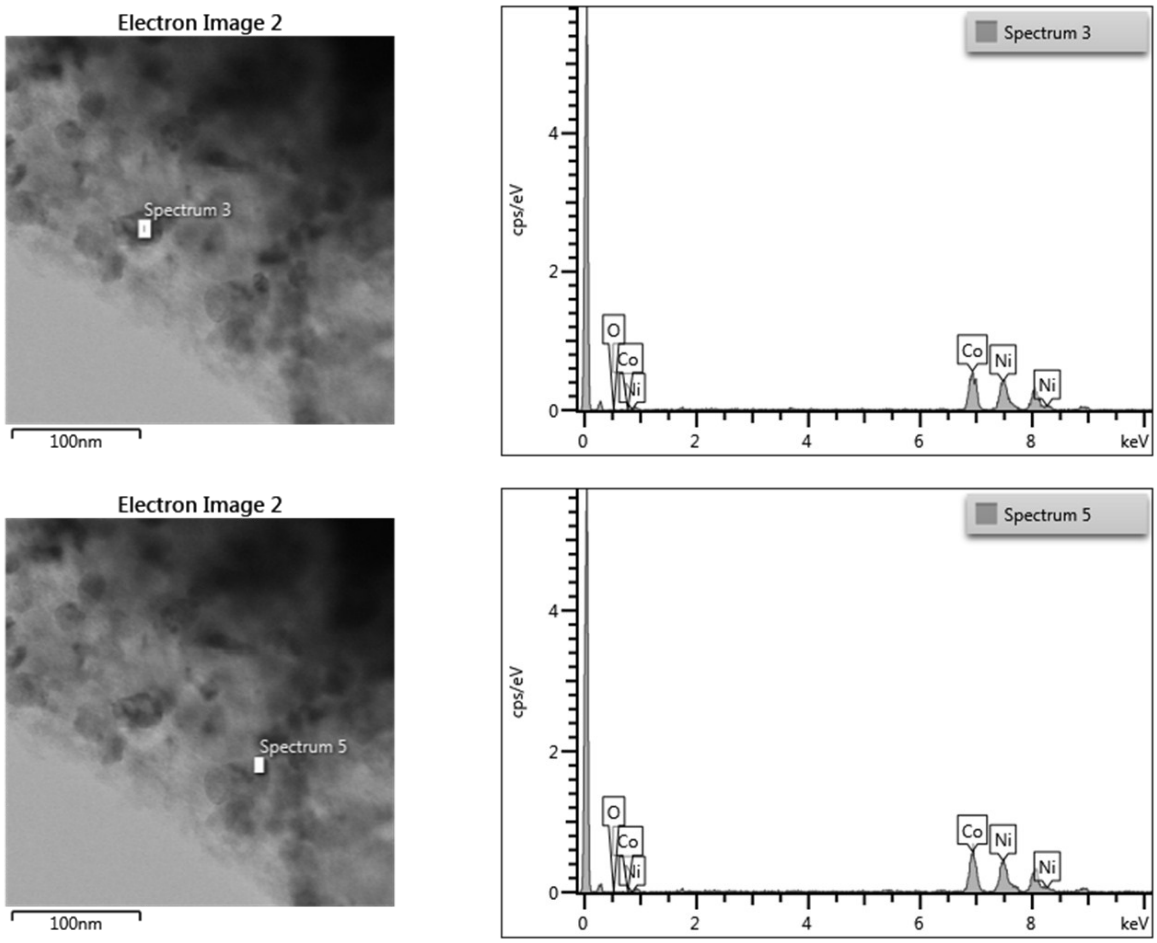


Fig. S2: SEM images of (a) NiO/GF, (b) CoO/GF.



	Spectrum 3		Spectrum 4	
Element	Wt%	Atomic%	Wt%	Atomic%
O	0.36	1.31	0.36	1.30
Co	55.86	55.24	57.07	56.44
Ni	43.78	43.45	42.58	42.27
Total	100	100	100	100

Fig. S3: EDX analysis of $NiCoO_2$ nanoparticles.

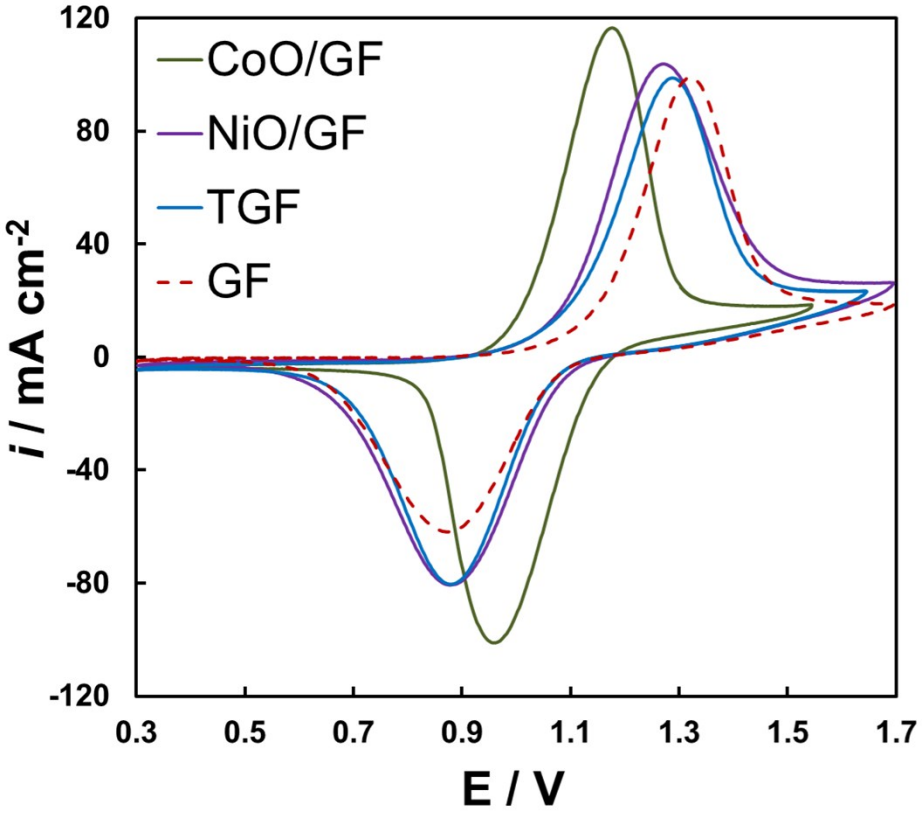


Fig. S4: Cyclic voltammograms of GF, TGF, NiO/GF and CoO/GF electrodes at a scan rate of 2.5 mv s^{-1} in 0.2 M $VOSO_4$ + 2 M H_2SO_4.

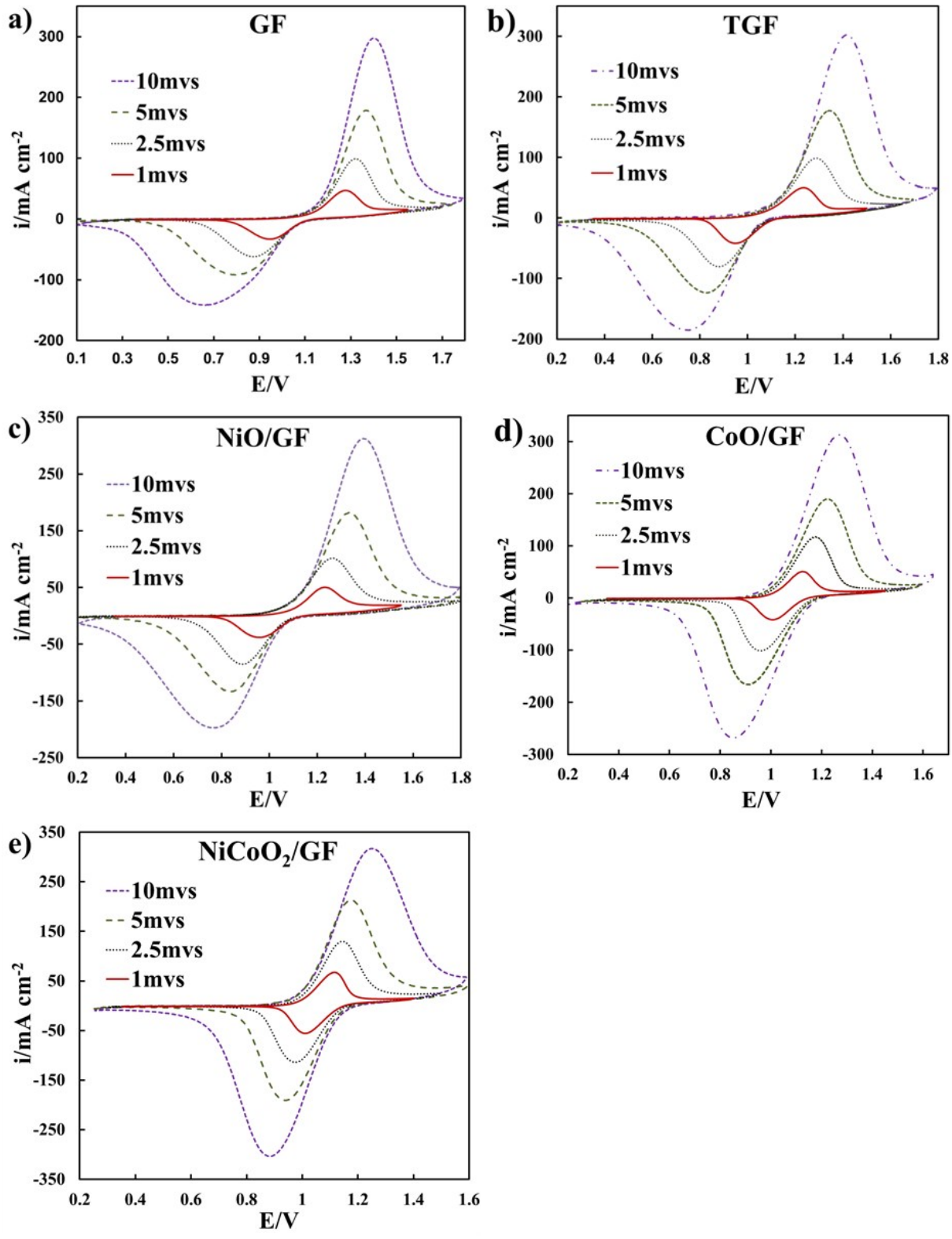


Fig. S5: Cyclic voltammograms of GF, TGF, NiO/GF, CoO/GF and $NiCoO_2$/GF electrodes at a scan rate of 1, 2.5, 5 and 10 mv s^{-1} in 0.2 M $VOSO_4$ + 2 M H_2SO_4.

For an irreversible and quasi-reversible redox reaction, the diffusion coefficient can be calculated according to Equation S1:

$$i_p = 2.99 \times 10^5 \alpha^{1/2} n^{3/2} A C D^{1/2} v^{1/2} \quad \text{(Equation S1)}$$

where i_p is the peak current density, n is the electron transfer in redox reaction, A is the surface area of the working electrode, C is the concentration of redox species in the electrolyte, D is the diffusion coefficient, v is the scan rate and α is the charge transfer coefficient.

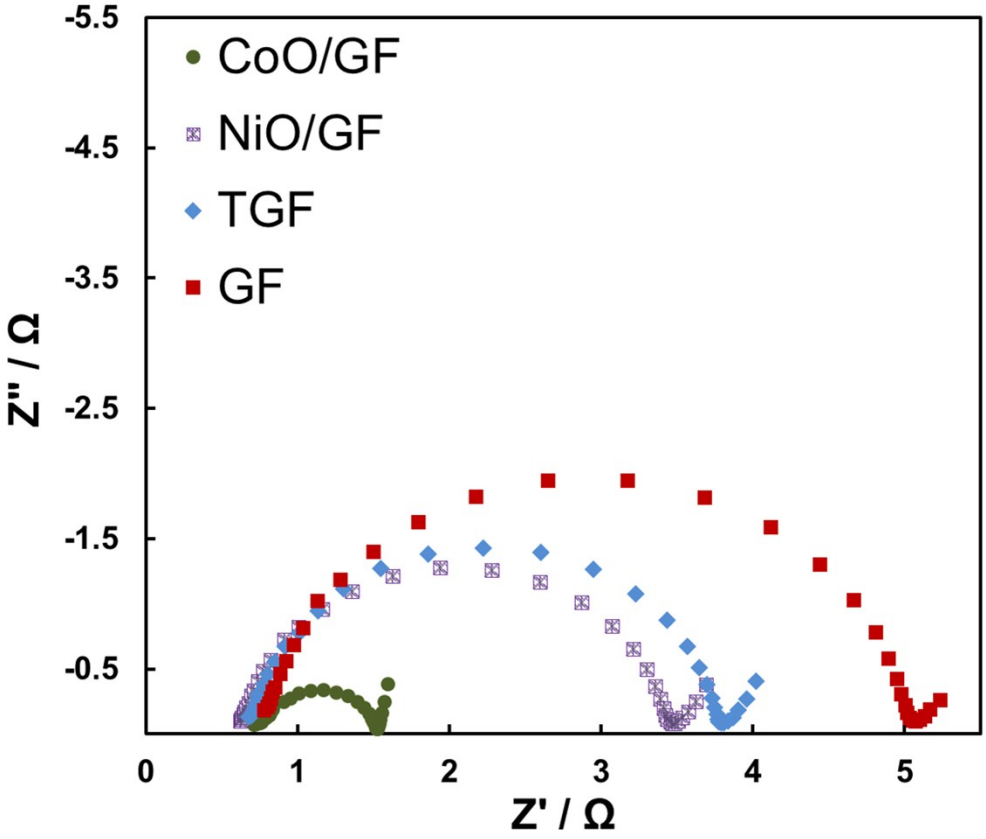


Fig. S6: Nyquist plots of GF, TGF, NiO/GF and CoO/GF electrodes in 0.1 M VO^{2+} / 0.1 M VO_2^+ in 2 M H_2SO_4.

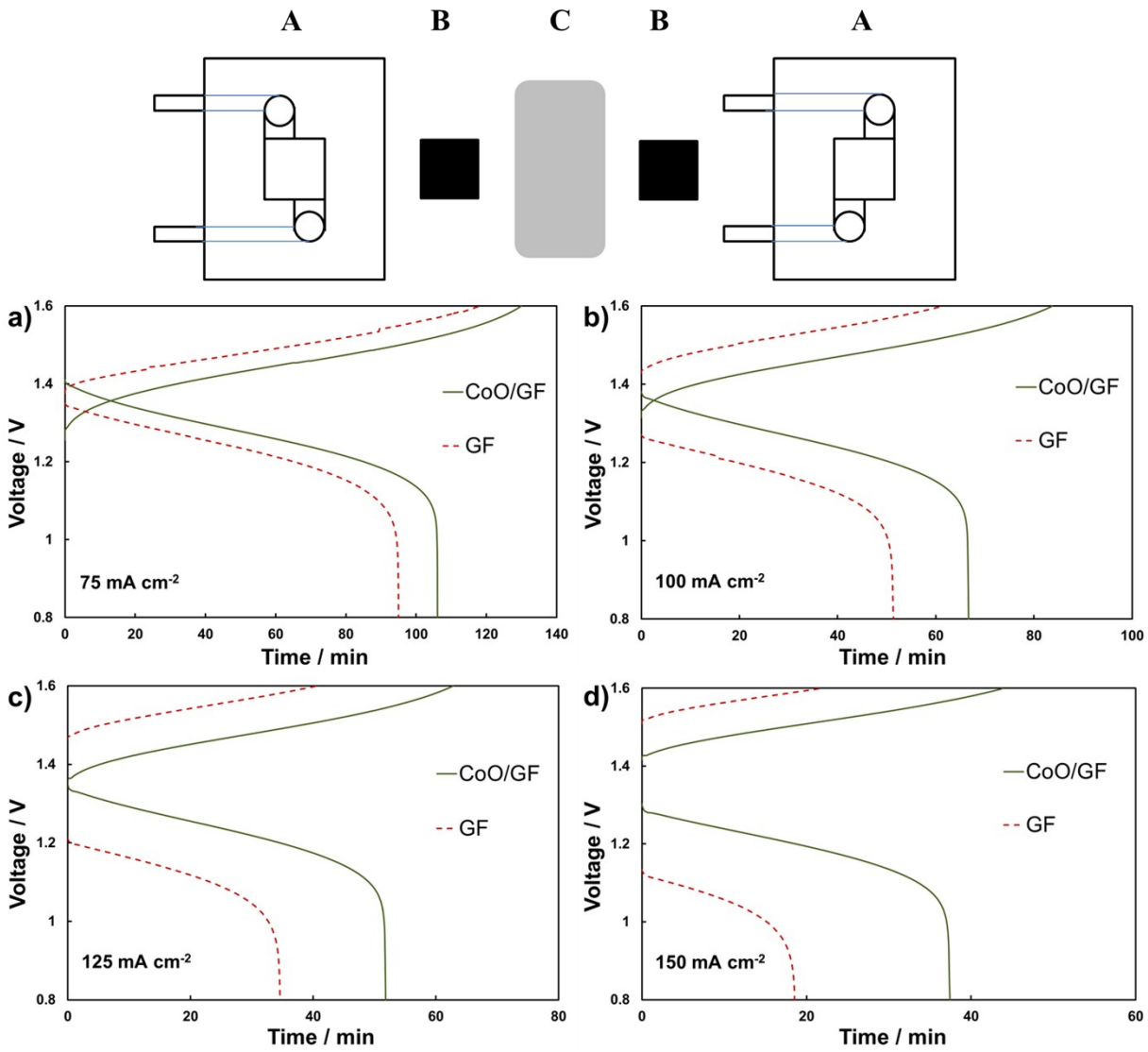


Fig. S7: Schematic of the key components of VRFB (A) flow frame plate (B) graphite felt (C) membrane and the cell performance of charge-discharge of the flow cells employing GF and CoO/GF electrodes at a constant current density of (a) 75 mA cm^{-2} (b) 100 mA cm^{-2} (c) 125 mA cm^{-2} (d) 150 mA cm^{-2}.

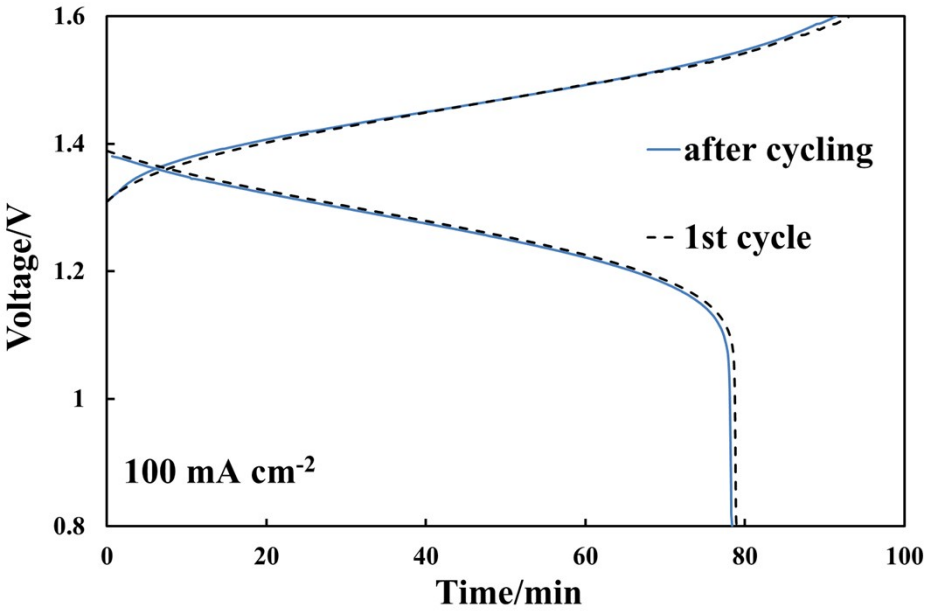


Fig. S8: Charge-discharge of the flow cell employing $NiCoO_2$/GF electrode. After 50 cycles, the electrolyte was refreshed using newly prepared solutions.

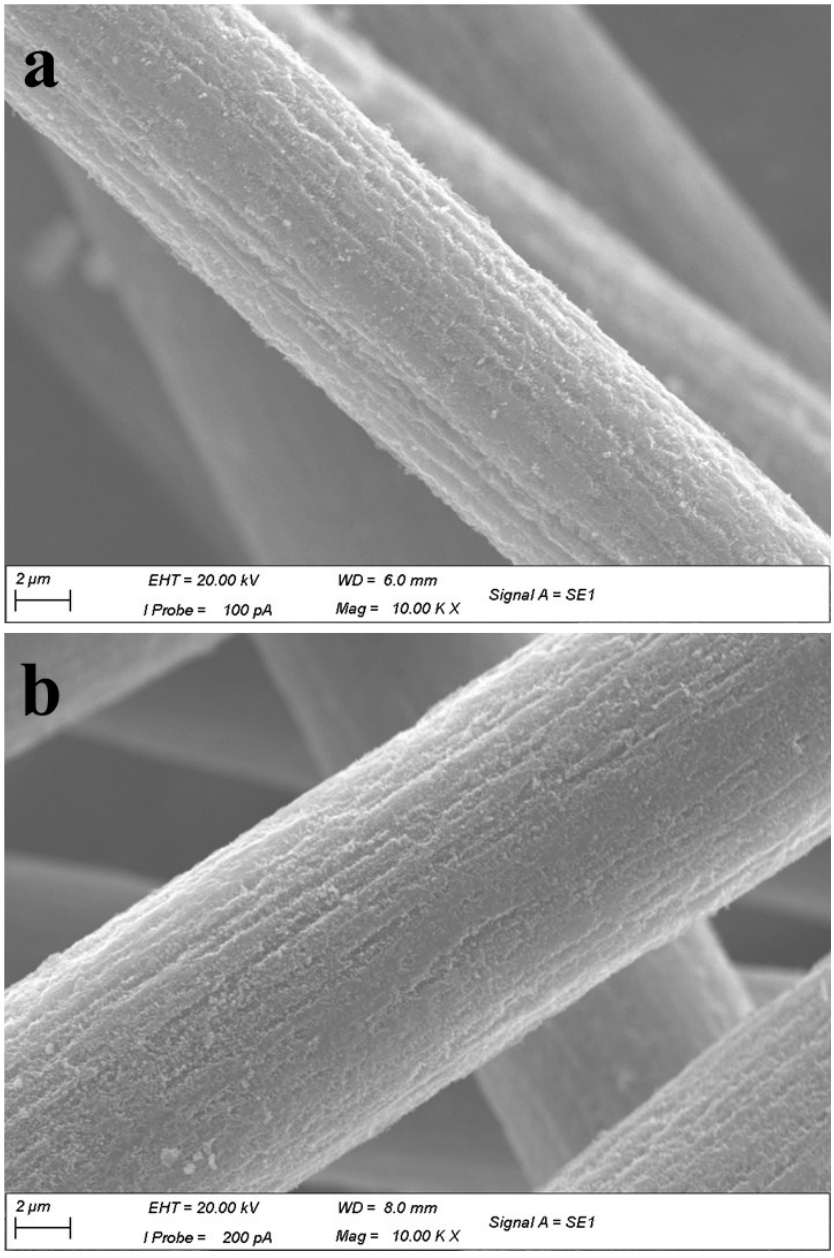


Fig. S9: SEM images of (a) $NiCoO_2$/GF before charge-discharge cycling; (b) $NiCoO_2$/GF after cycling.