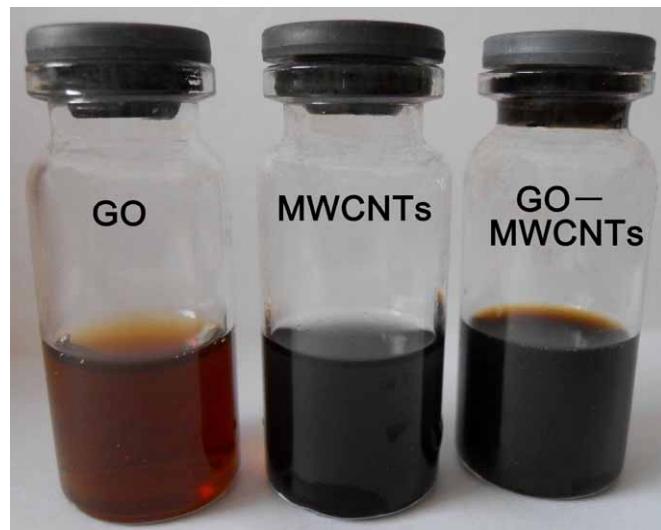


# Supporting Information for

## Graphene Oxide Nanosheets/Multi-Walled Carbon Nanotubes Hybrid Membrane as Excellent Electrocatalytic Material towards $\text{VO}^{2+}/\text{VO}_2^+$ Redox Couples for Vanadium Redox Flow Batteries

Pengxian Han, Yanhua Yue, Zhihong Liu, Wei Xu, Lixue Zhang, Hongxia Xu,

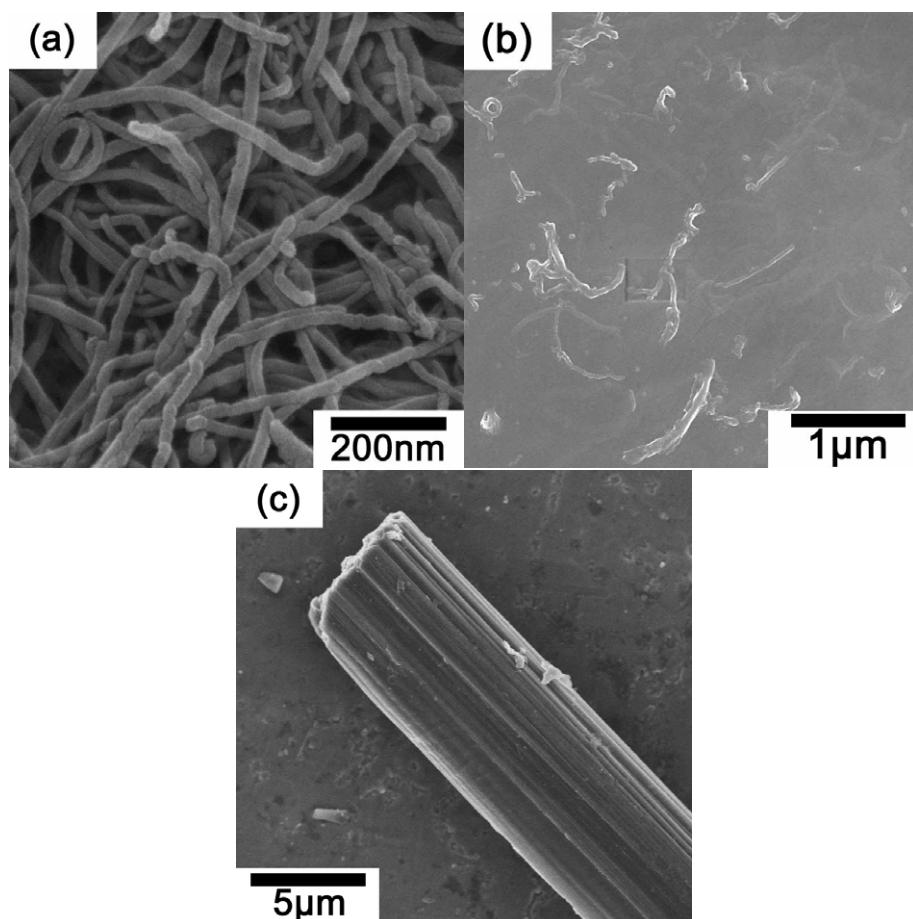
Shanmu Dong, and Guanglei Cui\*



**Figure S1.** Visible color difference photograph of GO nanosheets, MWCNTs and GO/MWCNTs composite solutions in ethanol at the same mass concentration.



**Figure S2.** AFM images and the corresponding height profile of GO nanosheets.



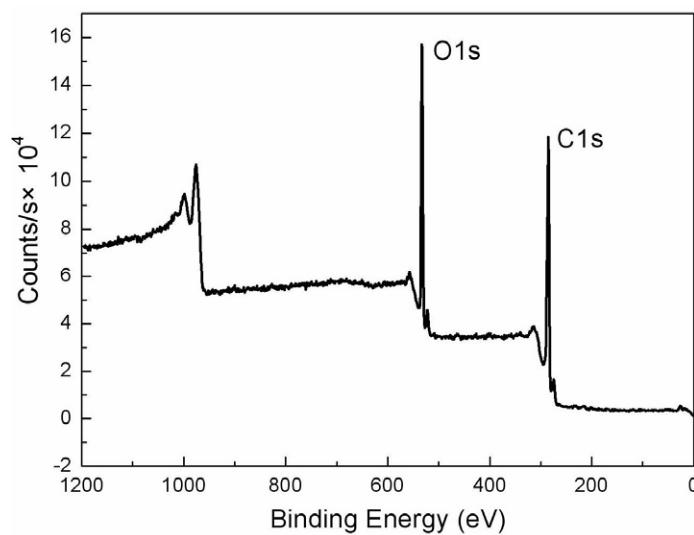
**Figure S3.** SEM images of (a) MWCNTs, (b) GO/MWCNTs, and (c) PGF.

**Table S1.** Relative percentages of functional groups on oxidized MWCNTs surface (%)

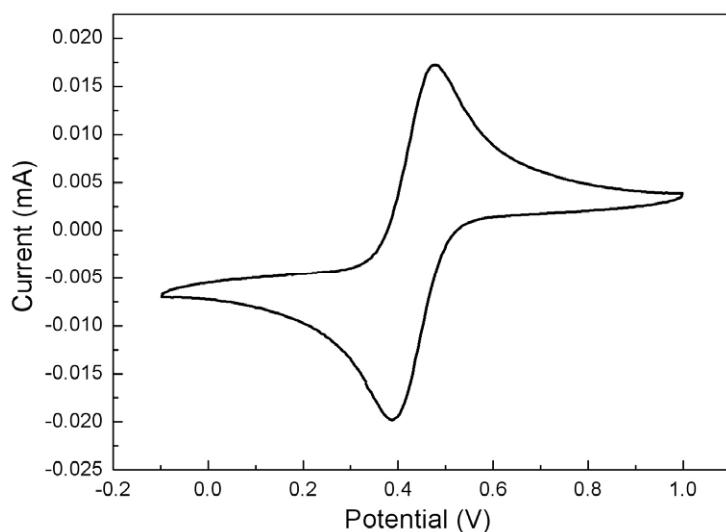
Samples	Elements		
	C1s	O1s	O/C ratio
Oxidized MWCNTs	75.82	24.18	0.32

**Table S2.** Functional groups obtained from curve fitting of C1s XPS spectra of oxidized MWCNTs (%).

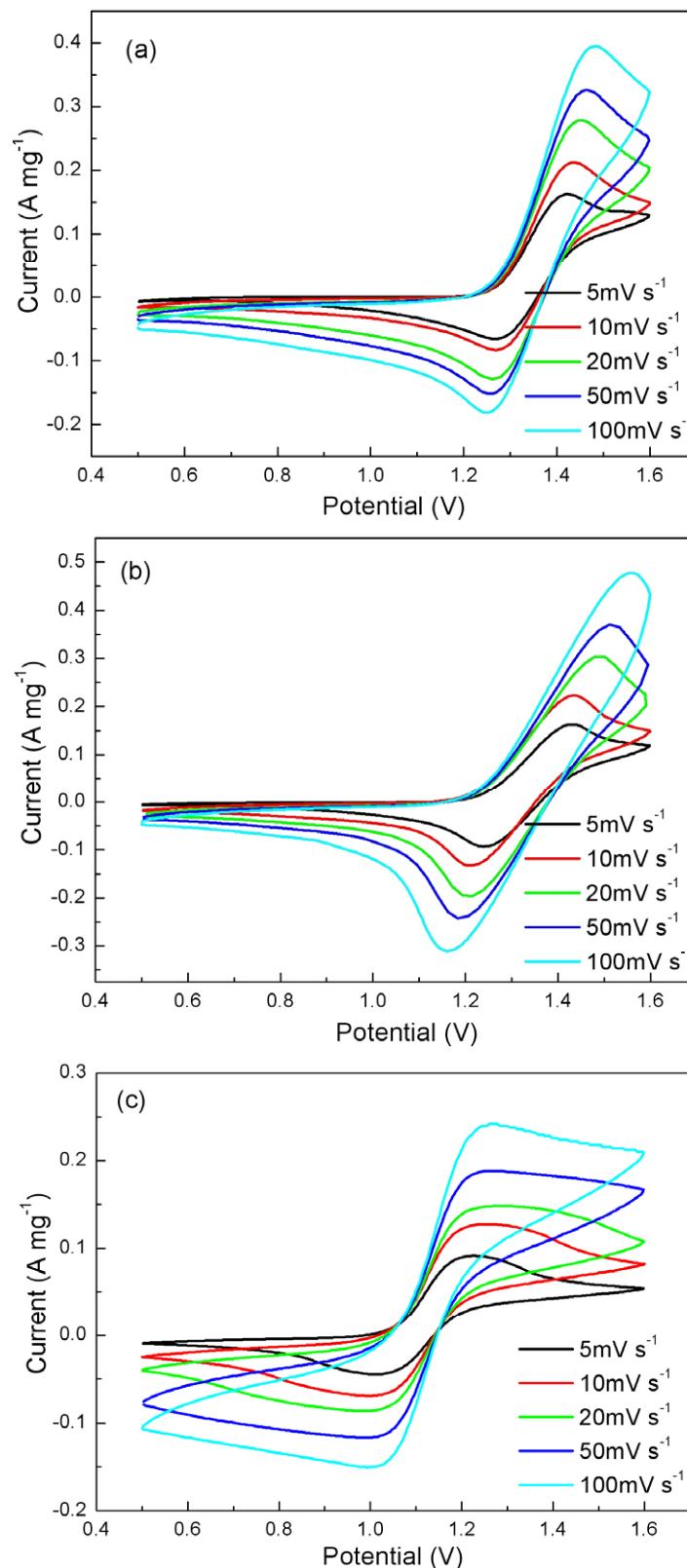
Sample	C-C sp <sup>2</sup> 284.5 eV	C-C sp <sup>3</sup> 285.6 eV	C-OH 286.3 eV	C-O-C 287.3 eV	-C=O 288.3 eV	COOH 289.8 eV
Oxidized MWCNTs	36.33	28.88	16.65	7.34	6.84	3.96



**Figure S4.** XPS general spectrum of oxidized MWCNTs.



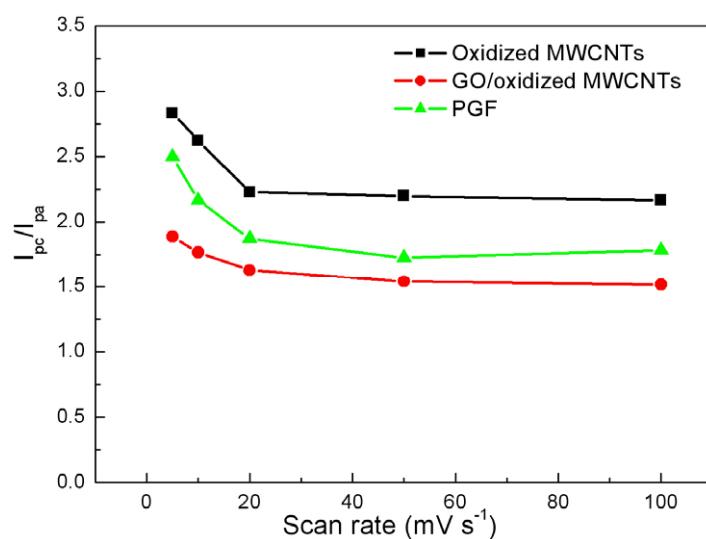
**Figure S5.** Cyclic voltammogram of  $2.0 \times 10^{-3}$  mol L<sup>-1</sup> K<sub>3</sub>[Fe(CN)<sub>6</sub>] + 0.2 mol L<sup>-1</sup> KCl solution at a clean, freshly polished bare GCE under the scan rate of 50 mV s<sup>-1</sup>.



**Figure S6.** Cyclic voltammograms of (a) oxidized MWCNTs, (b) GO/oxidized MWCNTs, and (c) PGF under different scan rates in  $2 \text{ mol L}^{-1} \text{ VOSO}_4 + 2 \text{ mol L}^{-1} \text{ H}_2\text{SO}_4$ .

**Table S3.** Peak currents density of  $\text{VO}^{2+}/\text{VO}_2^+$  redox couples under different scan rates.

Samples	Peak currents density [ $\text{A mg}^{-1}$ ]									
	5 $\text{mV s}^{-1}$		10 $\text{mV s}^{-1}$		20 $\text{mV s}^{-1}$		50 $\text{mV s}^{-1}$		100 $\text{mV s}^{-1}$	
	$I_{pa}$	$I_{pc}$	$I_{pa}$	$I_{pc}$	$I_{pa}$	$I_{pc}$	$I_{pa}$	$I_{pc}$	$I_{pa}$	$I_{pc}$
Oxidized MWCNT	0.15	0.04	0.21	0.08	0.29	0.13	0.33	0.15	0.39	0.18
GO/oxidized MWCNT	0.18	0.09	0.23	0.13	0.31	0.19	0.37	0.24	0.47	0.31
PGF	0.10	0.04	0.13	0.06	0.15	0.08	0.19	0.11	0.25	0.14



**Figure S7.** Curves of  $I_{pa}/I_{pc}$  as a function of scan rate for  $\text{VO}^{2+}/\text{VO}_2^+$  redox couples.