Supporting Information

Graphite felt electrode of quaternary ammonium doped for vanadium redox flow battery

Liu Xuejiao [1], Hu Junping [1]*, Liu Jun [1], Liu Hongyi [1], Fu Sha [1] and Wu Xiongwei [1]*, Wu Yuping [2]

1 School of Chemistry and Materials Science, College of Resources and Environment, Hunan Agricultural University, Changsha, 410128, China

2 State Key Laboratory of Materials-Oriented Chemical Engineering & School of Energy Science and Engineering, Nanjing Tech University Nanjing, Nanjing, 211816, China

* Correspondence: hjp864569039@163.com; wxw@hunau.edu.cn

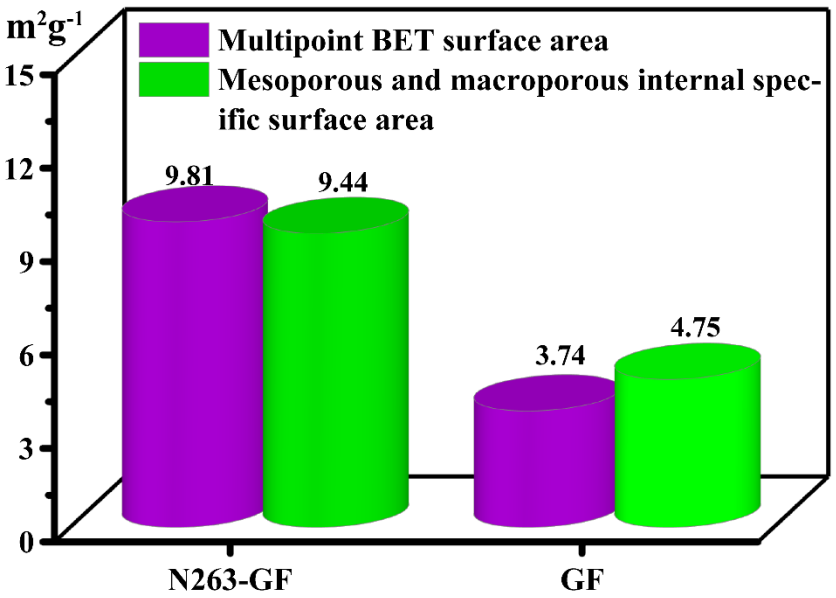

Figure S1. Results of multipoint BET specific surface area and mesoporous, microporous internal surface area tests on N263-GF, GF

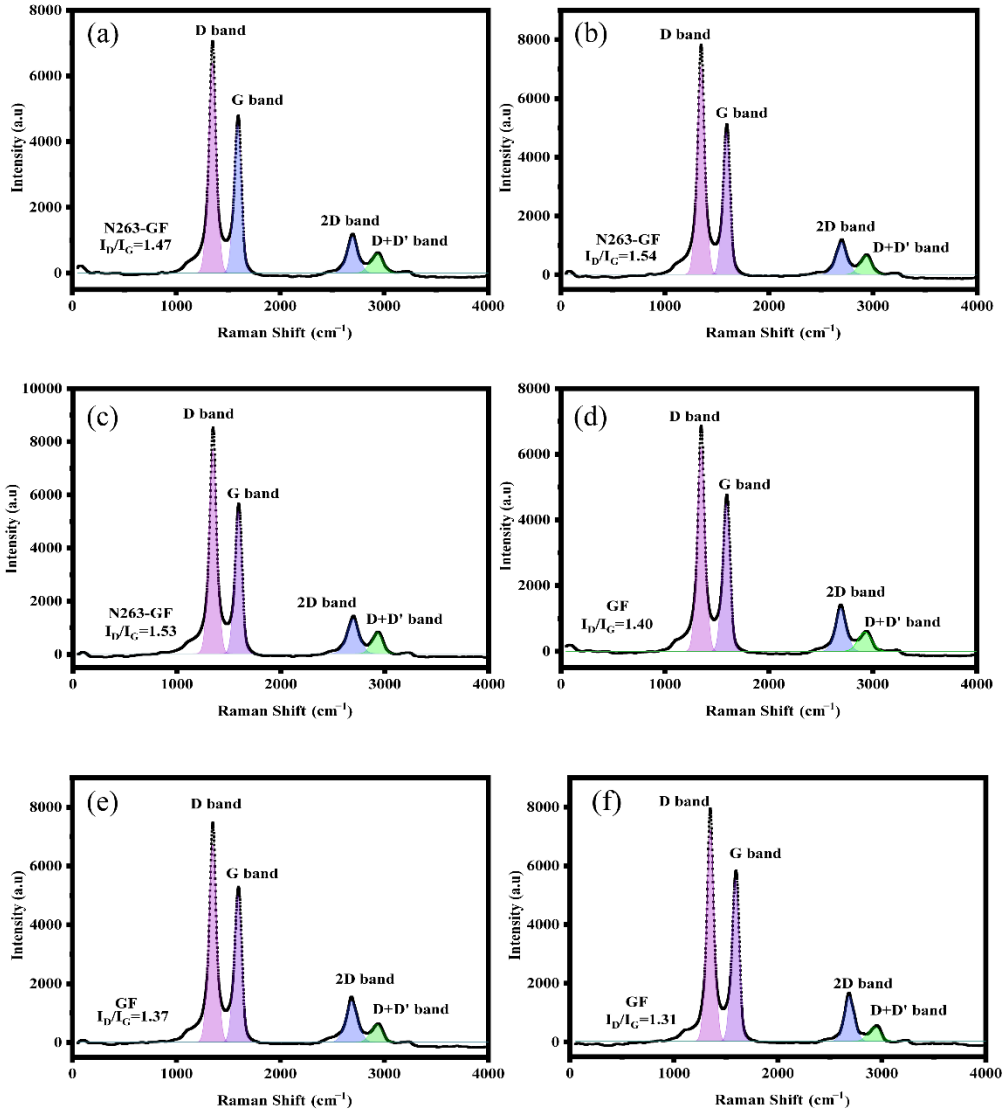

Figure S2. Raman spectra of different regions of N263-GF (a, b, c) and GF (d, e, f)

Table S1. Raman spectrometer test results in different regions of electrodes

Sample		D band area	G band area	I_D/I_G
N263-GF	a	647726	439151	1.47
	b	714705	462932	1.54
	c	779626	508132	1.53
GF	d	626680	447624	1.40
	e	683918	496714	1.37
	f	703982	538401	1.31

In the Table S1, Raman spectra were taken at three different locations on the electrode materials of N263-GF and GF of size 3×3 cm and labeled a, b, c and d, e, f.

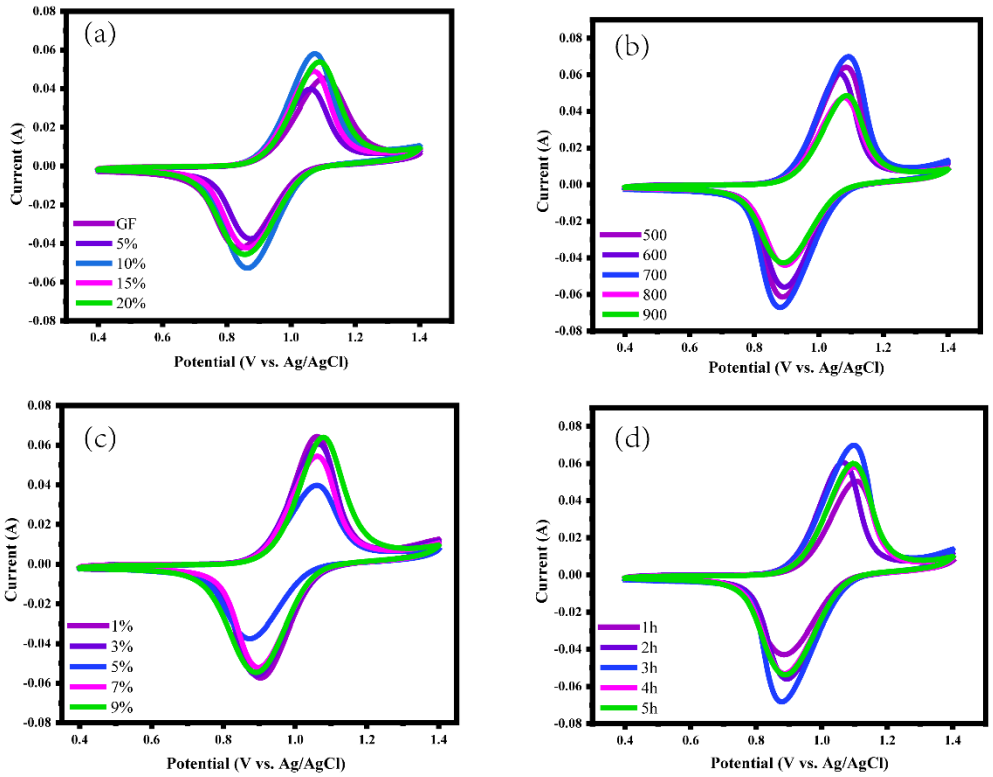

Figure S3. Comparison of cyclic voltammetry tests at 10mV/s for electrodes prepared under different conditions

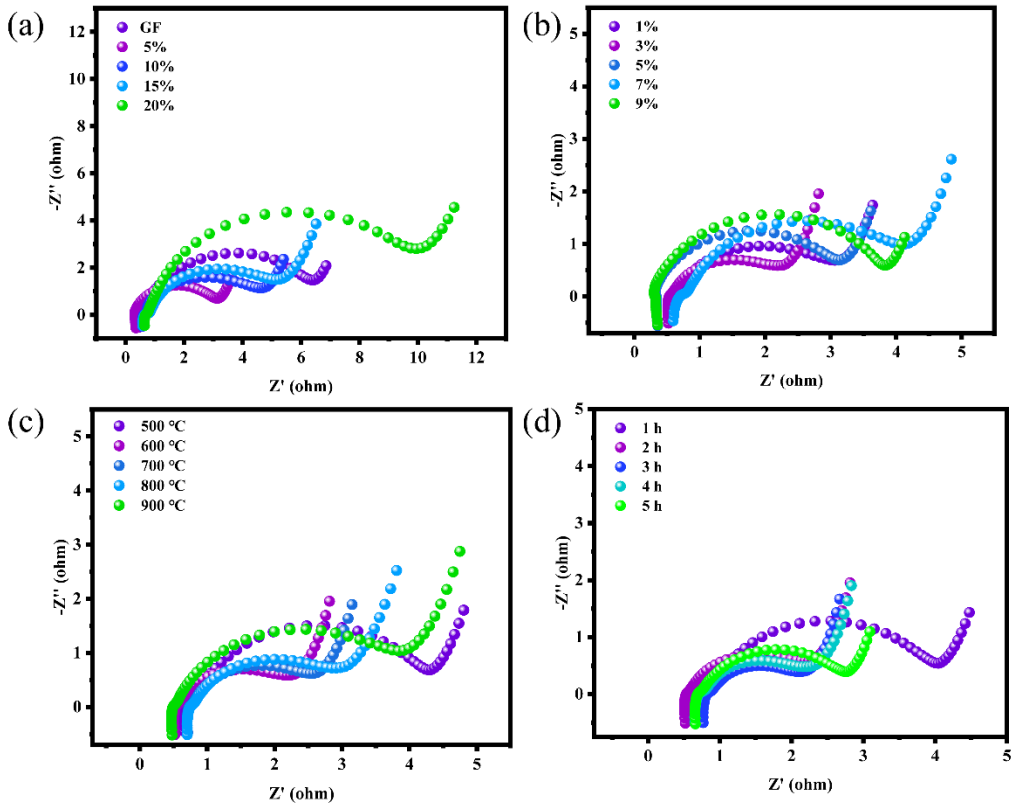

Figure S4. AC impedance diagram of electrodes prepared under different conditions

Single-factor experiments were conducted for the addition amount of N263, argon atmosphere treatment temperature and time, respectively. From Figure S3 and Figure S4, it can be seen that the best performing cell can be obtained by treating N263-GF in argon atmosphere at 600 °C for 2 h after adding 3% N263.

Table S2. Values of the AC impedance equivalent circuit elements

Sample	L1	R1	C1	R2	Wo		
					Wo-R	Wo-T	Wo-P
N263-GF	9.6128E-7	0.46974	0.029148	0.96924	4.579	2.373	0.45289
GF	1.0085E-6	0.43166	0.012483	4.31	5.553	7.136	0.39294

Table S3. Positive electrode vanadium ion diffusion coefficient

	Scan rate (mV s^{-1})	5	10	20	30	40
N263-GF	I_{po}/A (mA cm^{-2})	0.1032	0.1676	0.2732	0.3572	0.4272
	I_{pr}/A (mA cm^{-2})	-0.086	-0.1448	-0.2376	-0.3104	-0.3716
	Ko			0.0798		
	Kr			-0.0702		
	D_o (cm^2 s^{-1})			8.80×10^{-12}		
	D_r (cm^2 s^{-1})			6.81×10^{-12}		
GF	I_{po}/A (mA cm^{-2})	0.0696	0.1172	0.1916	0.2492	0.2976
	I_{pr}/A (mA cm^{-2})	-0.0568	-0.098	-0.1652	-0.2168	-0.2596
	Ko			-0.056		
	Kr			-0.050		
	D_o (cm^2 s^{-1})			4.33×10^{-12}		
	D_r (cm^2 s^{-1})			3.45×10^{-12}		

In the Table S3, The apparent diffusion coefficient D can be obtained by bringing the test results into the equation using CV tests with different scan rates of the positive electrode, where K is the slope value in Figure 5d.