Supporting Information

Poly(2-ethyl-aniline) blend membrane for vanadium redox flow battery

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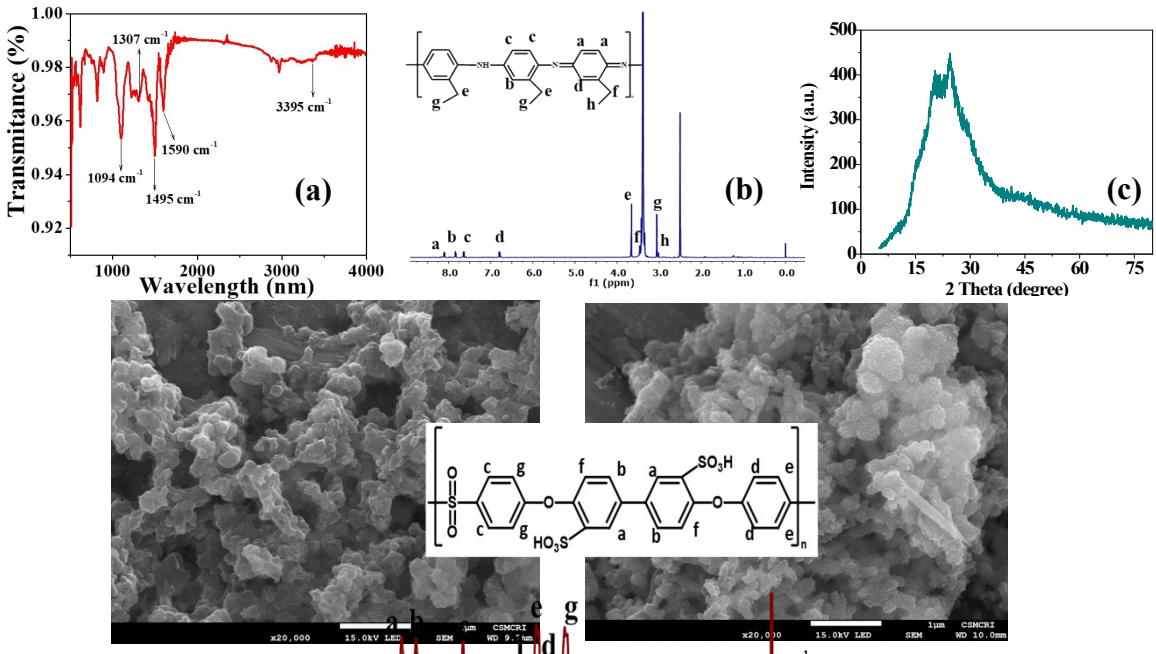

Fig. S2 E-PANI spectroscopic characterizations (a) FT-IR (b) ^{1}H NMR and (c) p-XRD, e) SEM image, f) PANI SEM image

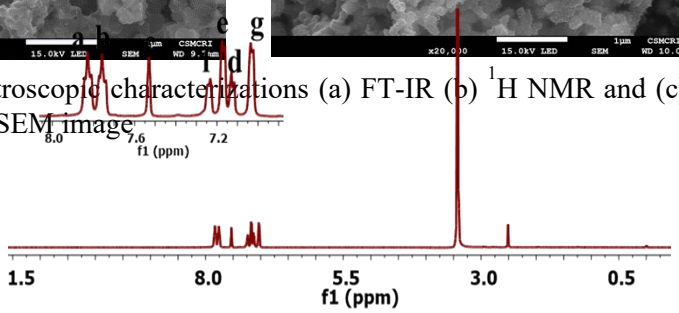

Fig. S3 ^{1}H-NMR spectra of sulfonated polyether sulfone

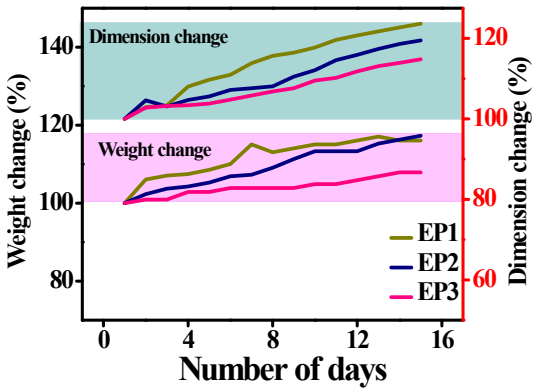

Fig. S4. Dimension and weight change evaluation of E-PANI composite membranes with respect to time

Table S1: The comparison of VRFB performance of PANI composite membranes with that of Prepared E-PANI-SPES

Membrane code	VRFB study	CD mA/cm^2	CE %	VE %	EE %	Charge-discharge cycling stability	Ref. no
SPEEK/PANi-GO-2	Rate performance	20	96.5	88.0	84.0	300 cycle at 30mA cm^{-2}	[1]
		30	97.5	84.0	82.0		
		40	98.0	78.0	77.0		
		50	98.5	75.0	74.0		
		60	99.1	70.0	69.0		
	Cycling test	30[a]	98.5	83.0	81.7		
SPEEK-E600/PANI = 80/20	Rate performance	20	97.0	94.0	91.0	30 cycles at 40 mA cm^{-2}	[2]
		30	98.0	93.0	92.0		
		40	98.5	92.5	91.0		
		50	99.0	92.0	90.0		
	Cycling test	40[b]	98.4	92.8	91.3		
EP3	Rate performance	20	90.5	85.0	77.0	300 cycle at 140mA cm^{-2}	[*]
		40	92.0	83.0	76.0		
		60	94.3	80.0	75.0		
		80	95.5	73.0	70.0		
		100	98.0	63.0	62.0		
	Cycling test	140	99.5	53.0	52.7		

composite membranes

Foot note: Cycle no. a=100, b=30, * present work, SPEEK/PANi-GO-2: SPEEK/polyaniline-functionalized graphene oxide

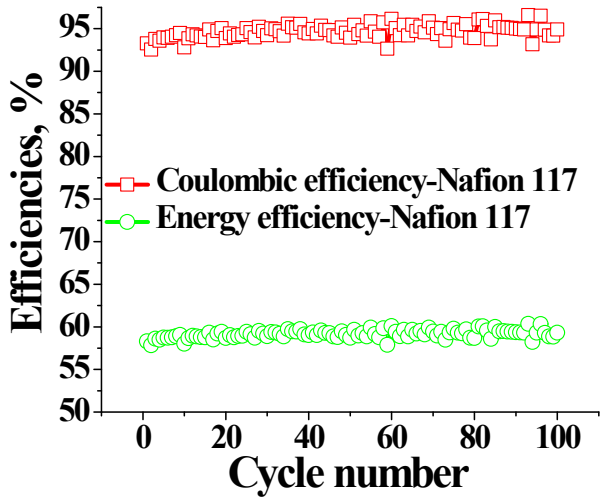

Fig. S5. Cycling battery performance of Nafion®117 at 100 mA cm^{-2}

Table S2. Comparative literature values of battery performance ion exchange membrane with synthesized membrane in VRFB

Membrane	**Current density** (cm^{-2})	**CE** (%)	**VE** (%)	**EE** (%)	**References**
SPEEK/HMN-6 composite membrane	120	~98	~80	82.1	3

S/O-bPn-1.5% composite membrane	100	98.3	~88	86.6	4
PAES-8mPip-x	60	94.78	90.15	85.44	5
bSPI/s-MWCNTs-2% composite membrane	80-160	~96	80%	77	6
sPSScl9	180	~92	~80	88	7
Sulfonated polyethylene–styrene–divinylbenzene	140	95	63	67	8
Poly (phenylene ether) QCPPAE	50	99.00	88	89	9
SPI/0.5% PDAP	100	96	87.02	84.04	10
s-FSPI	60	99	77.30	77	11
C6QPSF	60	98	93	91.10	12
SPEEK/ ETS10/ PTFE	100	98	78.80	77.90	13
MD2.0-10	80	99.30	83	82	14
p-TPN1	100	100	84.50	84.70	15
Sulfonated poly(terphenylene) (SPTP) blended with Polybenzimidazole (PBI)	100	99.50		86.20	16
TA15-SPBP membrane	80	99.1		87	17
PC50NB30	200	94	82	78	18
Q/S-AIEMs	20	98	~90	90	19
EP3	140	99.5	53.0	52.7	This work

Footprint: SPEEK- sulfonated poly(ether ether ketone), HMN- Phosphotungstic acid (HPW)-metal organic framework (MIL-101-NH2) nanohybrids, S/O- - sulfonated poly(ether ether ketone)/bPn- phosphorus nanosheet, PAES-8mPip-x- Piperidine ions based on poly(aryl ether sulfone)s; bSPI/s-MWCNTs-2% - sulfonated polyimide (bSPI)/Sulfonated multiwalled carbon nanotubes; sPSScl9- sulfonated poly(phenylene sulfide sulfone) with 9% crosslinking, QCPPAE – Quaternised chloromethylated poly(p-phenylene) and poly(arylene ether), SPI/0.5% PDAP - sulfonated polyimide (SPI) blend with poly [bis (4,4′- diaminobenzidine-2,2′-disulfonic acid) phosphazene] (PDAP), s-FSPI - fluorinated sulfonated polyimide, C6QPSF - Amphiphilic quaternary ammonium polysulfone (PSF) with hydrophobic hexane side chains, PANi-GO- Polyaniline-Graphene oxide, ETS10/ PTFE- Engelhard titanosilicate-10/ poly(tetrafluoroethylene), MD2.0-10- Cross-linked aromatic polyamide (PA) thin film membrane, p-TPN1- Poly(terphenylene), Sulfonated poly(terphenylene)/ Polybenzimidazole, TA15-SPBP membrane-sulfonated polybiphenyl tethered with pendant tertiary amine groups, PC50NB30- Perfluorinated sulfonic acid.

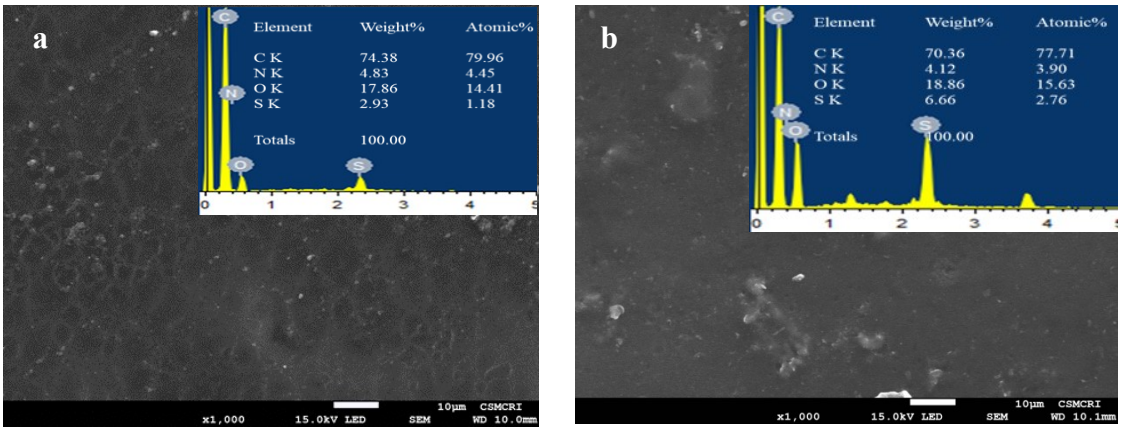

Fig. S5 Represent the surface morphology of EP3 membrane a) before and b) after battery performance showing no leaching of E-PANI.

Table S3 Comparison of electrochemical properties for E-PANI composite membranes and SPES before and after Battery performance

Membrane code	**Water content (%)**		**IEC (meq g^{-1})**		**Young modulus (MPa)**	
	Before	**After**	**Before**	**After**	**Before**	**After**
SPES	30.4	35.1	1.42	0.97	189	186.2
EP1	17.1	21.6	1.32	0.91	251	245
EP2	16.6	29.4	1.25	0.91	256	248
EP3	19.8	34.7	1.22	0.86	273	266

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