

## Support information:

### Nanofiltration (NF) membranes: the next generation separators for all vanadium redox flow batteries (VRB)?

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## Experimental part:

### Membrane preparation:

PAN (Scientific polymer product) membranes were obtained from a dimethyl sulfoxide/THF solution, which cast on a polypropylene support (Novatexx 2471, Freudenberg Filtration Technologies KG) and then solidified in water after certain time of evaporation (Table 1). The PAN-H membrane was obtained via hydrolysis in 10 wt% NaOH at 50 °C for 1h<sup>15</sup>

**Table 1** Membrane preparation parameters of M1-M3

Mark	mPAN/g	mDMSO/g	mTHF/g	Coating Thickness/ $\mu\text{m}$	Evaporation Time/s
M1	7.5	50	0	500	20
M2	7.5	40	0	500	20
M3	7.5	25	15	500	20

The polysulfone/sulfonated poly(ether ether ketone) (PSf/SPEEK) membrane was prepared via the phase inversion technique from casting solutions containing PSF

(Solvay Advanced Polymers, UDEL P1835) and SPEEK (Prepared by direct sulfonation of PEEK (VICTREX) with sulfuric acid at 60°C for 3 h<sup>22</sup>) in a weight ratio SPEEK/(PSf+SPEEK) of 0.1, dissolved in N,N-dimethylacetamide as a 25 wt% solution<sup>22</sup>. The solution was cast on a glass plate and immersed into de-ionized water for about 15 min.

### **Membrane characterization:**

SEM (JEOL 6360LV, Japan)) was carried out to characterize the cross-section structures of the membranes. The cross-section was obtained after breaking the membranes in liquid nitrogen. FE-SEM (Philip XL-30-ESEM- FEG)) was carried out to investigate the surface morphology of the membranes. All the samples were first gold coated before use.

### **VRB single cell test:**

The VRB single cell was fabricated by sandwiching a membrane with two carbon felt electrodes, clamped by two graphite polar plates. 1.5M V<sup>2+</sup>/V<sup>3+</sup> in 3.0M H<sub>2</sub>SO<sub>4</sub> solution and 1.5M VO<sup>2+</sup>/VO<sub>2</sub><sup>+</sup> in 3.0M H<sub>2</sub>SO<sub>4</sub> solution, serving as negative and positive electrolytes respectively, were cyclically pumped into the corresponding half-cell. The active area of the cell was 9 cm<sup>2</sup> and the volume of electrolyte solution was 30 ml in each half-cell. Charge-discharge cycling tests were conducted (LAND

CT2001A) at a constant current density of 80 mA/cm<sup>2</sup>. The maximum voltage of 1.65 V and minimum voltage of 0.8V for charge and discharge were employed to avoid the corrosion of carbon felts and graphite plates.