Supporting Information

High-performance of anion exchange blend membranes based on novel phosphonium cation polymers for all vanadium redox flow battery applications

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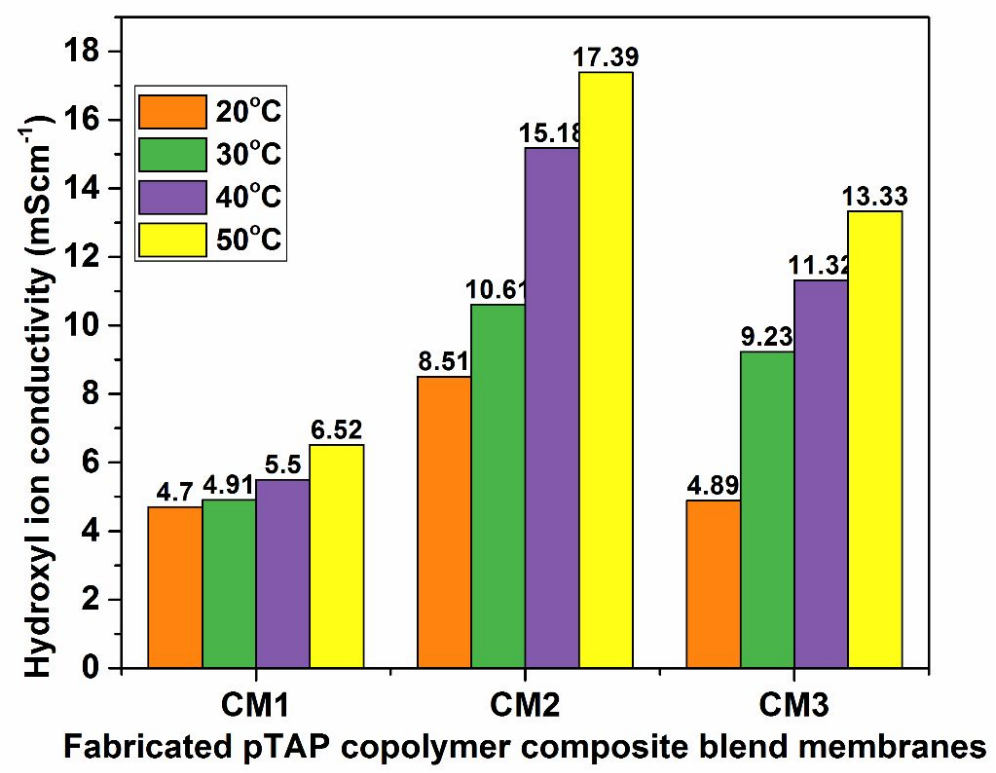

Figure S1. Hydroxyl ion conductivity of composite blend membranes CM1, CM2 and CM3 at different temperatures.

As shown in Figure S2, the crossover of vanadium ion through the membrane showed the different tendency depending on the membrane. It seems that the permeations of the vanadium ions through a membrane in a VRFB cell would depend on the membrane properties such as an ion selectivity, a membrane thickness and a membrane structure. The vanadium ion permeability of Nafion-212 after 200 hrs is calculated in the two compartment diffusion cell at ambient conditions was found to be in the order of 2.5×10^{-8} cm^2/s at 20 °C. From the figure it is understood that, all the composite blend anion exchange membranes had a low permeability of vanadium ion compared to a cation exchange membrane Nafion-212.

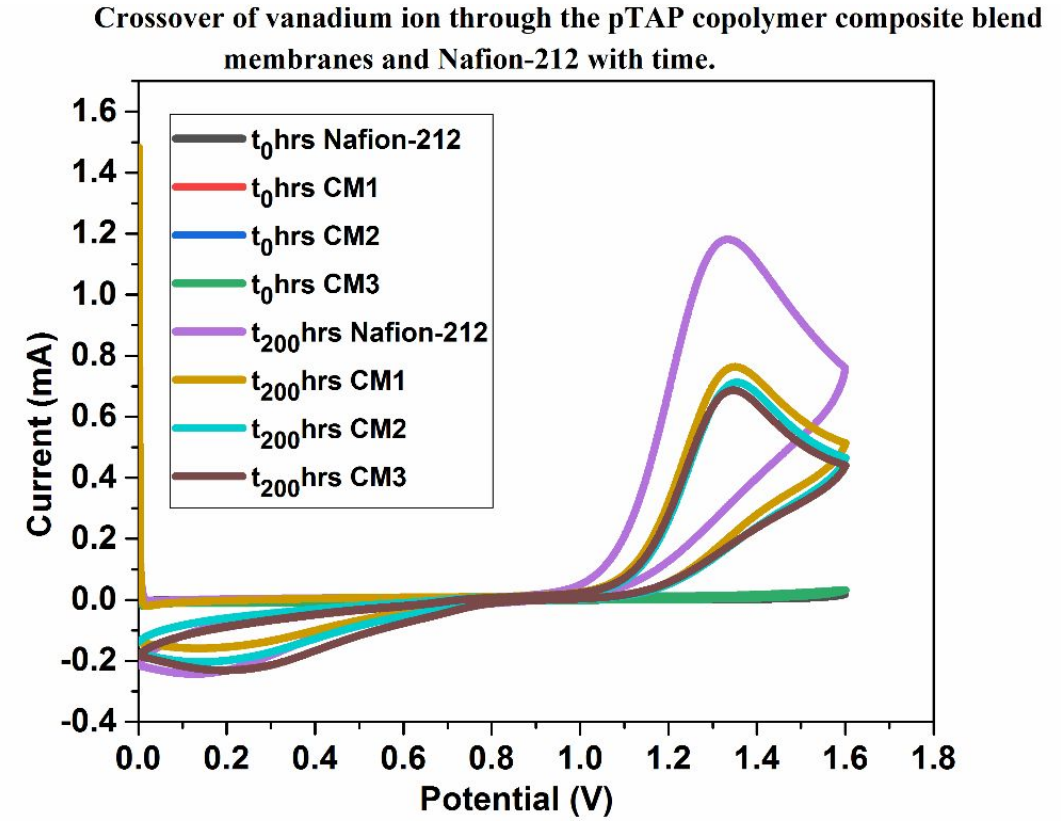

Figure S2. Comparison of vanadium ion permeability of Nafion -212 and pTAP composite blend CM1, CM2 and CM3 membranes.

Figure S3 shows the thermogravimetric analysis curves (TGA curves) for the pTAP copolymers CP1, CP2, CP3, chitosan and PVDF. The pTAP copolymers CP1-3 exhibit excellent thermomechanical stability up to ~350 °C under an N_2 atmosphere with only 3 % weight loss. The initial weight loss of about 5% in chitosan occurs below 100 °C is mainly due to the evaporation of water molecules. Chitosan shows no significant weight loss and is more stable between 100 and 280 °C. The weight loss above 350 °C is attributed to the decomposition of backbone. Until 450 °C, no significant weight was recorded in PVDF polymer, indicating high thermal stability.

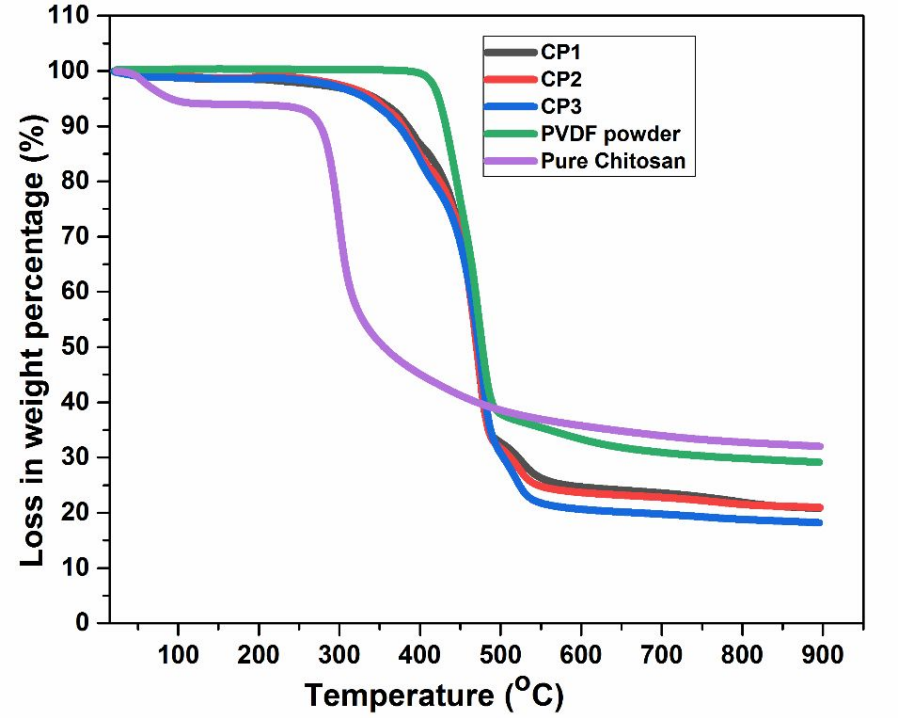

Figure S3. Thermograms for pTAP copolymers, chitosan and PVDF.