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Novel branched sulfonated polyimide/molybdenum disulfide nanosheets composite membrane for vanadium redox flow battery application

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Abstract: A novel branched sulfonated polyimide/molybdenum disulfide nanosheets (bSPI/MoS₂-ns) composite membrane was fabricated for vanadium redox flow battery (VRFB) application. Scanning probe microscope (SPM) and field emission-scanning electron microscope (FE-SEM) images verify the successful exfoliation of monolayer and a few layers of MoS₂ nanosheets. X-ray diffraction (XRD), attenuated total reflection-fourier transform infrared spectrometer (ATR-FTIR) and FE-SEM results demonstrate that bSPI, bSPI/MoS₂-ns and bSPI/MoS₂ nanopowders (bSPI/MoS₂-np) membranes are successfully prepared. Both thermogravimetric analysis/differential thermogravimetry (TGA/DTG) and ex-situ chemical stability testing results confirm bSPI/MoS₂-ns membrane has improved thermal and chemical stabilities in contrast with pristine bSPI membrane. The bSPI/MoS₂-ns membrane owns high proton conductivity ($5.04 \times 10^{-2} \text{ S cm}^{-1}$) and extremely low vanadium ion permeability ($0.65 \times 10^{-7} \text{ cm}^2 \text{ min}^{-1}$), leading to its highest proton selectivity ($7.75 \times 10^5 \text{ S min cm}^{-3}$) among all the membranes tested. Besides, during 500 times cycle charge-discharge test, the coulombic efficiency, energy efficiency and discharge capacity retention of VRFB using bSPI/MoS₂-ns membrane are higher than or comparable to those of VRFB using Nafion 117 membrane. And the surfacial morphological integrity of bSPI/MoS₂-ns membrane maintains better than reported pristine bSPI

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