

NOVEL NANOSTRUCTURED HIGH-PERFORMANCE ANION EXCHANGE IONOMERS FOR ANION EXCHANGE MEMBRANE FUEL CELLS

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A novel block copolymer, styrene-ethylene/butylene-styrene (SEBS), was chosen as the starting material to prepare pendant quaternary ammonium-based ionomers with an ion-exchange-capacity (IEC) of 0.66, 1.30, and 1.54 meq g⁻¹, denoted by QSEBS-L, QSEBS-M, and QSEBS-H, respectively. These QSEBS ionomers were demonstrated to have excellent dimensional stability against hydration without significantly sacrificing the ionic conductivity as compared to the widely studied polysulfone (PSf) based ionomers. The water uptake of the QSEBS-based ionomers depended on their functionality; a higher IEC in the ionomer resulted in more water uptake and a higher ionic conductivity. The MEAs fabricated with the QSEBS-M and QSEBS-H ionomers showed the best H₂/O₂ fuel cell performance with peak power densities reaching 210 mW cm⁻² at 50 °C, which was significantly higher than that of the PSf-based ionomers (~30 mW cm⁻²). Electrochemical impedance spectroscopy (EIS) analysis indicated that the superior fuel cell performance observed with the QSEBS-based ionomers can be attributed to: (1) the low internal cell resistance due to good comparability of the QSEBS-based ionomers with the membranes and (2) the low mass transport and charge transport in both the anode and the cathode due to the excellent dimensional stability and balanced conductivity-hydrophobicity originated by the unique morphology of the QSEBS-based ionomers. AFM phase imaging measurements of the QSEBS-based ionomers revealed unique nanostructures containing isolated hydrophobic and continuous anion conducting hydrophilic domains. By further optimizing the chemistry and morphology of the ionomers and the membranes, the resistance of the anode and cathode of the AEMFCs will be further reduced.

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