Molecular Engineering of Quaternary Ammonium Aromatic Polymers for Anion Exchange Membrane Fuel Cells

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Abstract

As a promising alternative to proton exchange membrane fuel cells (PEMFCs), anion exchange membrane fuel cells (AEMFCs) have received great attention in recent years. The high pH operating condition of AEMFCs allows use of non-precious metal catalysts and less expensive metal hardware. Recently, a power density over 1.0 W cm^{-2} has been achieved for AEMFC approaching close to that of PEMFCs. One of key requirements for high performance of AEMFCs is anion exchange membranes (AEMs) with high ion conductivity, good chemical stability and mechanical durability. New materials development using novel polymer backbones and side chain ionic functional groups have been extensively investigated over the past decade.

In this study, we will present the effects of different structures of polymer backbones and the location of ionic side chains on the membrane properties of AEMs and their fuel cell performance. Polymers made of soft backbone, such as polystyrene-*b*-poly(ethylene-*co*-butylene)-*b*-polystyrene (SEBS), and rigid backbones, such as polyarylenes containing biphenyl and terphenyl core groups (namely BPN and TPN series), have been evolved from my group at RPI over the past years. Because the backbone of those polymers are made of all carbon-carbon bonds, they showed excellent chemical stability under alkaline conditions. The high molecular weights (>100,000 g/mol) of those functionalized polymers also afforded good mechanical strength and high strain when made into film. A perspective of quaternary ammonium-functionalized polymers that have been developed from RPI will be presented with emphasis on synthetic strategy and materials performance in AEMFC test condition.