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Perspective

General Study on Sulfonated Poly(Arylene Ether Benzimidazole) Copolymers

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DESCRIPTION

Both 5,5'-bis[2-(4-hydroxyphenyl)benzimidazole] (HPBI) and disodium-3,3'-disulfonate-4,4'-dichlorodiphenylsulfone (SDCDPS) monomers were synthesised. Sulfonated poly(arylene ether benzimidazole) copolymer was created *via* a nucleophilic aromatic polycondensation process to bind these monomers. Proton Nuclear Magnetic Resonance (1H NMR) spectroscopy and Fourier Transform Infrared (FTIR) spectroscopy analysis were used to confirm the structures of the monomers and copolymers. The copolymer was dissolved in Dimethylacetamide (DMAc) and cast onto a glass plate to create the proton exchange membrane. To assure proton exchange properties, sulfuric acid was doped into the copolymer membrane. A polymer electrolyte membrane fuel cell test station was used to evaluate the copolymer membrane's single-cell performance. Thermogravimetric Analysis (TGA) revealed that the copolymer's thermal stability increases with increase in disulfonation levels.

The development of fuel cell technology over the past 25 years has been prompted by the environmental problems associated with the use of fossil fuels, the negative health impacts of toxic emissions, and industrial nation's belief on oil, which causes oil crises. Future electrical energy production that is both highly efficient and ecologically friendly is thought to be best served by fuel cells. Polymer Electrolyte Membrane Fuel Cells (PEMFCs) are one of the fuel cell types that have received the most attention due to their high power density, high energy transformation efficiency, and wide range of fixed and portable device applications.

Modern membranes, like Nafion®, are based on perfluorosulfonic acid and are extensively employed in PEMFCs because of their exceptional chemical and physical stabilities, high proton conductivity, and low operating temperatures. The disadvantages of Nafion membranes, such as their high cost, the need for humidification, and their reduced proton conductivity at temperatures above 80℃, are still being studied in the development of alternative polymer electrolyte membranes. Polymer electrolyte membrane research has mostly focused on studies of polymer-based sulfonated proton exchange membrane materials, including poly (arylene ether sulfone), poly (ether ether ketone), poly (arylene thioether), poly (phenylene), and polyimides.

The proton exchange membrane fuel cells are a promising use for sulfonated poly(arylene ether sulfone). Many researches has focused on fully aromatic poly (arylene ether sulfone) copolymer, as it differs from Nation in a number of positive ways; poly(arylene ether ketones), thioether analogues, partly flourinated systems, and high-performance PEMs that contain nitrile or phosphine oxide. Due to their exceptional compatibility with Nafion electrodes, partly flourinated coplymers that contain nitrile have particularly outstanding long-term DMFC performance. Beacuse of their interactions with sulfonic acid groups on the copolymer chian, basic moieties in copolymers such as nitriles and phosphine oxides have unique characteristics.

A very simple polymer called Polybenzimidazole (PBI) has drawn a lot of interest as a potential fuel cell material for proton exchange membranes. Strong acids like sulfuric acid and phosphoric acid interact well with the imidazole ring because of its basic character. For example, even from diluted aqueous solutions, PBI may absorb substantial amounts of phosphoric acid. A recent unique technique has been revealed for loading PBI membranes with significant amounts of phosphoric acid.

Polyphosphoric acid was used to create polybenzimidazoles, which were then immediately cast from the polymerization solvent and hydrolyzed to phosphoric acid using the sol-gel method. The high acid doping levels are probably what caused the membranes to exhibit inherent high proton conductivities even at low humidity levels.

Direct copolymerization increases the acidity of the proton-conducting sites in sulfonated poly(arylene ether sulfones), allows for fine control of the ion exchange capacity, and enhances the thermal and mechanical stability. The proximity of the sulfone moiety to the sulfonic acid groups is thought to boost their acidity, which also improves heat stability. The direct synthesis of novel sulfonated poly(arylene ether)s from sulfonated monomers has been demonstrated by our group. The resulting copolymers

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differ from conventional post-sulfonated materials in a number of ways. The water absorption of the directly copolymerized materials is lower at comparable ion exchange capacities due to the inclusion of two sulfonic acid sites per repeat unit.

This makes it possible to increase the mechanical stability and endurance of membrane electrode assemblies.

By using either an activated substituted difluorobenzimidazole or a bisphenol that contains the benzimidazole, poly(arylene ether benzimidazole)s have been created. Aryl fluorides can be activated towards nucleophilic displacement by heterocyclic functions such as imides, benzoxazoles, and benzdimidazoles since they are sufficiently electron withdrawing. Nevertheless, since the sulfonated monomer is also an activated dihalide, using such monomers would not result in enough benzimidazole units. The high molecular weight copolymers, as judged by the inherently high intrinsic viscosities, made tough, ductile membranes when cast from DMAc.