Anion Exchange Membrane for Alkaline Membrane Fuel Cells (#5003)

Several AEMs that possess high conductivity and high ion selectivity while exhibiting good chemical stability at elevated temperatures in alkaline electrochemical environments

Inventors at Georgia Tech have prepared several AEMs that possess high conductivity and high ion selectivity while exhibiting good chemical stability at elevated temperatures in alkaline electrochemical environments. The researchers have utilized aromatic polymers in this endeavor due to their robust thermal and mechanical properties coupled with their oxidative resistance and stability at a range of pH levels. Initially, the researchers synthesized partially fluorinated, polyaromatic-based condensation polymers containing ionic functionality located along the polymer backbone. Higher conductivity AEMs were achieved by increasing the density of quaternary ammonium groups and the polymer was cross-linked to reduce the membrane’s susceptibility to swelling. Subsequently, an ethynyl moiety was introduced as the thermal cross-linkable group which successfully increased the thermo-oxidative stability, chemical resistance, and dimensional stability. The membrane also had good ion conductivity without decreasing the IEC value of the membrane. The cross-linking procedure was optimized to enhance the ionic channels within the membrane. Finally, the researchers developed a synthetic pathway that avoids the use of chloromethylation reagents, which are both toxic and prohibitively expensive.

Benefits/Advantages

- AEMs produced with high ionic conductivity coupled with thermo-oxidative resistance at a range of pH levels
- Increases density of quaternary ammonium without increasing the AEMs susceptibility to swelling
- Avoids the use of chloromethylation reagents which are both toxic and expensive

Potential Commercial Applications

- Production of anion exchange membranes
  - Fuel cells
  - Electrolyzers
  - Flow batteries
- Electro-dialysis
  - Aqueous electrolyte solutions
- Diffusion dialysis:
  - Recover acid or alkali-based solutions and waste
Background/Context for This Invention

Although fuel cells have the potential to deliver clean energy, their promise has not yet been realized. Traditional proton or cation exchange membrane (PEM or CEM) fuel cells are expensive, in large part due to the price and future availability of the platinum-based catalyst. Anion exchange membranes (AEMs) are being investigated as a promising alternative to PEMs and CEMs. Most AEMs are based on cross-linked polystyrene, which tend to be unstable in alkaline or electrochemical environments. Further, the poor physical properties of many AEMs necessitate blending with other polymers or fabric supports that can further reduce the ionic conductivity and stability of the membrane. Thus, there is a need for new AEMs that exhibit chemical stability and high conductivity and ion selectivity in an electrochemical environment.

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