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Sulfonated Poly(phenylene sulfone)s with High Ion Exchange Capacity

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Abstract Text:

Abnormal phenomena caused by climate change require the realization of carbon neutrality while ensuring a stable supply of energy (energy security). Climate change is mainly caused by environmental pollution from human society, and in recent years, research and development of environmentally friendly materials for practical use has been carried out.

Energy devices such as fuel cells, water electrolysis, and RFB have polymer electrolyte components that transport ions, and up until now, fluorine-based electrolytes such as Nafion have been mainly used. However, within the framework aiming to achieve carbon neutrality, the development of materials containing fluorine is thought to be subject to restrictions. Therefore, there is a need for alternative materials to fluorine-based electrolytes.

We are conducting research aimed at the practical application of sulfonated PPSU, a hydrocarbon electrolyte, as a non-fluorine electrolyte [1-6]. In this study, we report the synthesis and properties of sulfonated PPSU with high ion exchange capacity (IEC) (calculated value: 5.55meq/g), which has four sulfo groups per repeating unit of PPSU.

SPPSU (2S), which has two sulfo groups per repeating unit of PPSU (IEC=3.57meq/g), was obtained by sulfonation of bis(4-fluorophenyl)sulfone using 30% Oleum. Next, polymerization was performed by condensation reaction of sulfonated bis(4-fluorophenyl)sulfone (SFPS) and 4,4'-biphenol (BP). Furthermore, by sulfonating these polymers in sulfuric acid, SPPSU (4S) having four sulfo groups per repeating unit (IEC=5.55meq/g) was synthesized. The molecular weight of SPPSU(4S) was 130,304 – 303,203. Depending on the sulfonation conditions using SPPSU(2S) polymer and sulfuric acid, the viscosity of SPPSU(4S) was 30 to 270 mP·s, which was higher than that of Nafion (D520CS), which was 10 to 40 mPa·s. In addition, the tensile strength, tensile elongation, and flexural modulus of SPPSU (4S) were 22 MPa, 251%, and 296 MPa. Compared to Nafion 212, it exhibited high tensile strength and flexural modulus while having similar tensile elongation properties. Furthermore, the conductivity of SPPSU (4S) was 11.3 mS/cm at 120°C and RH 10%. This value was approximately 4 times higher than the conductivity of Nafion212 (3.2 mS/cm) under the same conditions.

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Symposium Selection:

I01C - Polymer Electrolyte Fuel Cells and Water Electrolyzers 24 (PEFC&WE 24) - Ionomers, Membranes and Separators for Fuel Cells and Electrolyzers

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Preferred Presentation Format:

Poster

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