Nanofiber-reinforced composite Proton-Exchange Membranes

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Significance and Relevance

This work aims to develop innovative proton exchange membranes (PEMs) with superior performance compared to traditional membranes based on Nafion. This study is focused on Aquivion-based membranes reinforced with electrospun fibers produced using different types of polymers, including polyvinylidene fluoride (PVDF) and sulfonated poly ether ether ketone (SPEEK). Results indicate that thinner membranes improve proton conductivity while keeping good mechanical properties.

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Introduction and Motivations

New proton exchange membranes, made by Aquivion[1] and reinforced with electrospun fibers, are developed and characterized in this study to find the optimal formulation to enhance RFB performance by balancing efficiency and reducing self-discharge[2].

Materials and Methods

Membranes were fabricated using Aquivion reinforced with three types of electrospun supports: PVDF, organic-inorganic hybrid of PVDF copolymer and SiO_2, and SPEEK. The membranes were characterized using advanced techniques such as scanning electron microscope (SEM), thermal gravimetric analysis (TGA), differential scanning calorimetry (DSC), stress-strain tests, water uptake measurements, and proton conductivity and area-specific resistance (ASR) by impedance spectroscopy (EIS). These properties were analyzed to assess efficiency and chemical stability.

Results and Discussion

In this work, we present the results of using the fabricated Aquivion-based membranes with different types of electrospun reinforcement materials to highlight their respective advantages and limitations. The discussion focuses on the mechanical and chemical stability of the membranes and their proton conductivity. The influence of membrane composition, thickness, and reinforcement strategy on the transport properties is analyzed, along with the role of water uptake in facilitating proton transport and its correlation with the type of reinforcement material used. The morphology of the membranes, particularly the integration of the electrospun mats and their impact on structural stability, is examined in detail and related to their proton transport behaviour.

References

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