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# Hexyl quaternary ammonium- and fluorobenzoyl-grafted SEBS as hydrophilic–hydrophobic comb-type anion exchange membranes

Abu Zafar Al Munsur<sup>a,b</sup>, Junghwa Lee<sup>a,b</sup>, Ji Eon Chae<sup>c</sup>, Hyoung-Juhn Kim<sup>c</sup>, Chi Hoon Park<sup>d</sup>, Sang Yong Nam<sup>e,\*</sup>, Tae-Hyun Kim<sup>a,b,\*</sup>

<sup>a</sup> Organic Material Synthesis Laboratory, Department of Chemistry, Incheon National University, 119 Academy-ro, Yeonsu-gu, Incheon, 22012, South Korea

<sup>b</sup> Research Institute of Basic Sciences, Incheon National University, 119 Academy-ro, Yeonsu-gu, Incheon, 22012, South Korea

<sup>c</sup> Fuel Cell Research Center, Korea Institute of Science and Technology, Seoul, 136-791, South Korea

<sup>d</sup> Department of Energy Engineering, Gyeongsang National University, Jinju, South Korea

<sup>e</sup> Department of Materials Engineering and Convergence Technology, Gyeongsang National University, Jinju, South Korea

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## ABSTRACT

The new hydrophilic–hydrophobic comb-type anion exchange membrane (AEM) was prepared from SEBS grafted with hexyl quaternary ammonium (HQA) and fluorobenzoyl. As confirmed by XRD and TEM, a better phase separation was obtained by adding a highly hydrophobic fluorine-substituted pendant as an enhanced hydrophobic spacer to the conducting head group (which contained a hexyl spacer as a hydrophilic unit). The HQA-F<sub>1</sub>-SEBS and HQA-F<sub>5</sub>-SEBS membranes, with fluorobenzoyl and pentafluorobenzoyl pendants, respectively, showed enhanced hydrophobicity compared to their non-fluorinated counterpart (HQA-SEBS). The highest hydroxide ion conductivity (87.0 in water and 14.37 mS cm<sup>-1</sup> at 95% RH) was obtained at 80 °C with HQA-F<sub>5</sub>-SEBS, which exhibited the most thermodynamic incompatibility between hydrophilic and hydrophobic units. The mechanical properties (tensile strength and Young's Modulus) of the HQA-F<sub>5</sub>-SEBS membrane were also improved; they were almost 2.5 times higher than those of the HQA-SEBS. The HQA-F<sub>5</sub>-SEBS showed a current density of 500 mA cm<sup>-2</sup> at a potential of 0.6 V and a peak power density of 354 mW cm<sup>-2</sup>. It also showed stable-cell durability for up to 100 h. Compared with the typical hydrophilic comb-type SEBS membrane and the previously reported SEBS-based AEM, its cell performance was significantly higher.

## 1. Introduction

To repair the environmental degradation caused by the use of traditional fossil fuels, there is growing interest and demand for the development of renewable energy technologies around the world [1,2]. Fuel cell is an environmentally friendly technology that can effectively convert chemical fuels into electricity through an electrochemical oxidation process with high energy density. Using different electrolytes in distinct fuel cells, alkaline fuel cells based on anion exchange membranes (AEMFCs) allow faster oxygen reduction reactions (ORR) in highly alkaline environments, so they can be achieved using non-precious metal catalysts [3–6]. Compared with fuel cells based on proton exchange membranes (PEMFC), these systems are also competitively priced because they can use anion exchange membranes (AEM)

based on non-perfluorocarbon polymers [7–9]. Because of these advantages, AEMFC has been receiving much attention in the past ten years.

Nonetheless, AEMFCs lag far behind PEMFCs in terms of industrial commercialization. One of the most important reasons for this is that, unlike PEM materials, only a few AEM materials have been developed that provide levels of ion conductivity and physicochemical stability equivalent to those of Nafion as a PEM material [10–14]. Making AEMFCs as competitive as existing PEMFCs hence requires the development of AEMs that not only ensure high hydroxide conductivity but also provide outstanding chemical (or alkaline) stability under actual fuel cell operating conditions, that is, at high temperatures and in alkaline conditions.

At a similar level of ion exchange capacity (IEC), the hydroxide ion

\* Corresponding author. Organic Material Synthesis Laboratory, Department of Chemistry, Incheon National University, 119 Academy-ro, Yeonsu-gu, Incheon, 22012, South Korea.

\*\* Corresponding author.

E-mail addresses: [walden@gnu.ac.kr](mailto:walden@gnu.ac.kr) (S.Y. Nam), [tkim@inu.ac.kr](mailto:tkim@inu.ac.kr) (T.-H. Kim).

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