Title
(2021-2022 ECS Toyota Young Investigator Fellowship) Understanding and Suppression of Cation Transport into Polymer Electrolyte Membrane Fuel Cell

Journal
ECS Meeting Abstracts, MA2022-02(39)

ISSN
2151-2043

Authors
Arman, Tanvir Alam
Sabharwal, Mayank
Neyerlin, Kenneth C
et al.

Publication Date
2022-10-09

DOI
10.1149/ma2022-02391408mtgabs

Understanding and Suppression of Cation Transport into Polymer Electrolyte Membrane Fuel Cell

Tanvir Alam Arman [a,b], Mayank Sabharwal [c], Kenneth C Neyerlin [d], Jacob S. Spendelow [a], Adam Weber [c], Rangachary Mukundan [a], Rod Borup [a], Siddharth Komini Babu [a]

[a] Los Alamos National Laboratory
[b] University of Connecticut
[c] Lawrence Berkeley National Laboratory
[d] National Renewable Energy Laboratory

Polymer electrolyte membrane fuel cells (PEMFCs) are a viable zero-emissions option for the electrification of the heavy duty transportation sector. However, PEMFCs still suffer from degradation of materials over the fuel cell lifetime. Cation contaminants can be generated from corrosion of bipolar plates and balance of plant components, water contaminants, and environmental sources (e.g., Fe^{3+}, Ca^{2+}, Na^{+}), making them present in the fuel or oxidant stream during operation(1). Cations have been shown to be detrimental to the performance of the PEMFC by reducing water uptake, ionic conductivity, and O_2 transport, resulting in performance loss and degradation. Metal cations such as Fe^{3+} can also lead to chemical degradation of the membrane ionomer (2-4). It is critical to understand the mechanism and rate of cation transport from the bipolar plate channel to the membrane to develop mitigation strategy to suppress the cation transport.

In this work, we present the study of the cation (Fe^{3+}) transport mechanism through the gas diffusion layer (GDL) by introducing a cation solution in the cathode channel. Transport rates across the GDL are studied using an ex-situ GDL holder where Fe solution is introduced in the GDL substrate side with water transported through to the microporous layer side (MPL) and is collected and analyzed for Fe concentration, as shown in Figure 1a. Effect of the Fe concentration on transport rates is also studied using computational modeling. Understanding of the transport mechanism is then leveraged to identify mitigation solutions and suppress cation transport from the flow field to the electrode using a GDL with dual MPL architecture as shown in Figure 1b. Optimization of the dual MPL architecture for both durability and performance is also presented.

Acknowledgements: This research is supported by the 2021-2022 ECS Toyota Young Investigator fellowship and U.S. Department of Energy (DOE) Hydrogen and Fuel Cell Technologies Office, through the Million Mile Fuel Cell Truck Consortium (M2FCT). Authors acknowledge the Laboratory Directed Research and Development (LDRD) program at Los Alamos National Laboratory (LANL).

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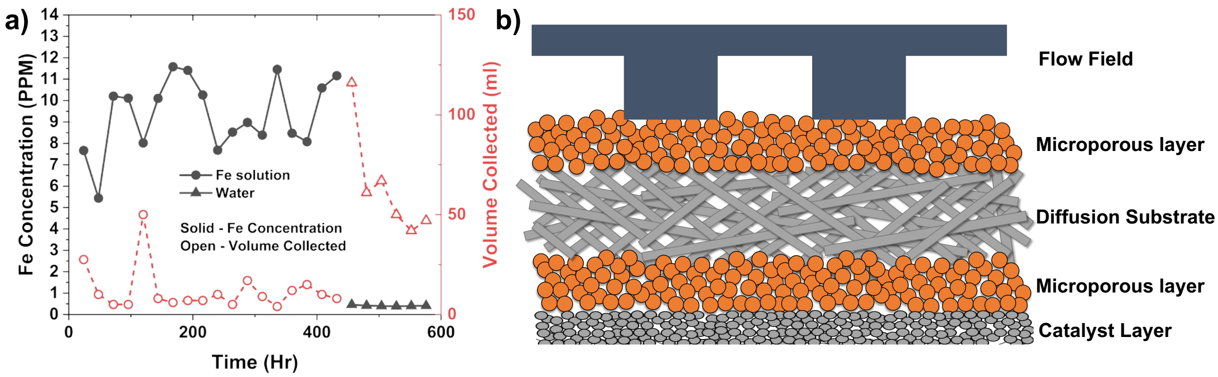

Figure 1. a) Iron concertation and amount of water collected from the MPL side of 29 BC when 10 PPM Fe solution is supplied on the substrate side. b) New GDL architecture with dual microporous layer on either side of the substrate