Development and Evaluation of Polyacrylonitrile-co-methyl acrylate (PAN-MA) Nanofiber Borax Decahydrate and Silica Composite Membranes for Potential Application as Proton Exchange Membranes in Fuel Cells

Seda Köksal Yegin[1*,2], Mualla Öner[1*], Julie Salme[3] and Michael Richter[3]
[1*]Chemical Engineering, Yildiz Technical University, Turkey, presenting author
(seda.yegin@ionmembranes, muallaoner@gmail.com)
[2]Ion Membrane Company, Turkey
[3],Hycenta Hydrogen Center Austria, Austria

INTRODUCTION

In response to the increasing energy demand today, the majority of produced energy is derived from fossil fuels, which has increased the amount of greenhouse gases in the atmosphere. Excess greenhouse gases, which cannot be mitigated by natural processes like photosynthesis, cause global warming due to the heat they trap. This situation leads to changes in the seasons and reveals the processes of climate change [1]. As a solution, efforts are being made to reduce emissions arising from energy production by promoting the use of renewable energy options that generate zero emissions [2]. Hydrogen technology is of great importance in this regard, as it enables energy production with zero emissions [3]. The method commonly used for electricity generation from hydrogen is the polymer electrolyte membrane fuel cell [4]. The membranes currently used in polymer electrolyte membrane fuel cells contain perfluorosulfonic acid, which is harmful to the environment and human health. These membranes begin to lose water in their structure at temperatures above 90°C, weakening their ionic conductivity and becoming mechanically less resilient. As a solution to these disadvantages, studies are being conducted to develop hydrocarbon-based membranes [5].

EXPERIMENTAL/THEORETICAL STUDY

In this study, a composite nanofiber membrane structure has been created by incorporating borax decahydrate and silica additives into poly(acrylonitrile-co-methacrylate) polymer. This structure has been doped with phosphoric acid. Samples were analyzed using EIS, DMA, FTIR, XRD, and TGA techniques.

RESULTS AND DISCUSSION

Based on these results, it can be concluded that the addition of borax decahydrate as an additive in proton conductive membranes can enhance ionic conductivity.

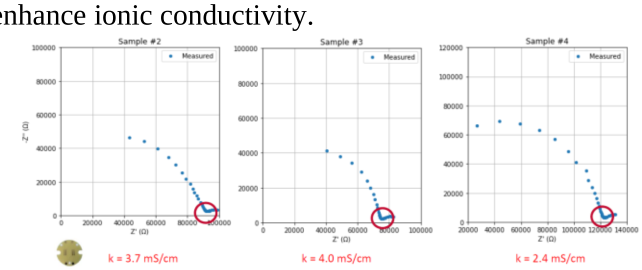

Fig. 1 Electrochemical impedance spectroscopy nyquist plots

CONCLUSION

This finding has important implications for the development of improved membranes for various applications in the field of proton exchange membranes and fuel cells.

REFERENCES

[1] M. T. Kiley, "Growth at Risk From Climate Change", Finance and Economics Discussion Series Divisions of Research & Statistics and Monetary Affairs Federal Reserve Board, Washington, D.C., 2021
[2] S. Matemilola and H. A. Salami, "Net Zero Emission", Springer Nature Switzerland AG, 2020
[3] S. G. Nnabuife et al., "The prospects of hydrogen in achieving net zero emissions by 2050: A critical review", Sustainable Chemistry for Climate Action 2, 100024, 2023
[4] E. S. V. Rheenen, et al., "Hydrogen carriers for zero-emission ship propulsion using PEM fuel cells: an evaluation", Journal of Marine Engineering & Technology, vol. 23- 3, 166–183, 2024

[5] S. H. Korzeniowski at al., “A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers”, Integrated Environmental Assessment and Management, Vol. 19-2, 326–354, 2022

ACKNOWLEDGMENTS
This work has been supported by the Research Fund of the Yıldız Technical University. Project Number: FDK-2022-4816.