PhD Open Days

Development of membranes and electrodes for direct liquid fuel cells with enhanced performance

PhD in Chemical Engineering

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Fuel cells are electrochemical energy conversion devices that provide clean power for stationary and portable devices, reducing the dependence on fossil fuels.

Direct borohydride fuel cells (DBFCs) using $NaBH_4$ as a fuel and hydrogen peroxide (H_2O_2) as the oxidant are ideal power sources for space and underwater applications.

$BH_4^- + 8OH^- \rightarrow BO_2^- + 8e^- + 6H_2O$ $E^0 = -1.24$ V vs. SHE (1)

$H_2O_2 + 2e^- + 2H^+ \rightarrow 2H_2O$ $E^0 = 1.77$ V vs. SHE (2)

$BH_4^- + 4H_2O_2 \rightarrow BO_2^- + 6H_2O$ $E = 3.01$ V (3)

This PhD thesis focuses on the test of electrocatalysts (anode and cathode) and the development of new anion- (AEM) and cation-exchange membranes (CEM), as well as bipolar membranes. The membranes will be tested for their conductivity, composition, thickness, mechanical strength, and ion exchange capacity (IEC), to describe the ion transfer.

Finally, the fuel cells will be 3D printed and assembled in lab scale using the anodes, cathodes, and membranes that presented the best activity and stability.

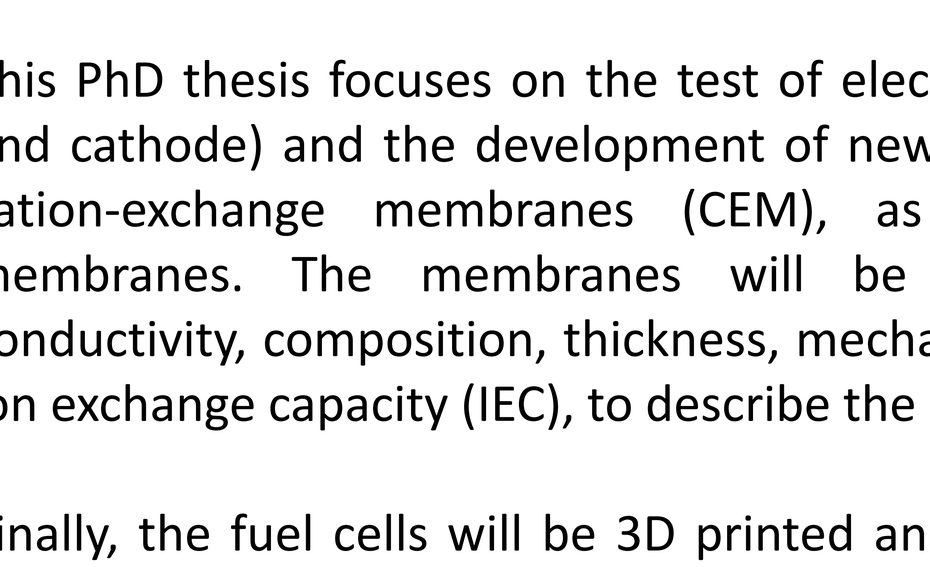

Fig. 3. Laboratory scale printed fuel cells.

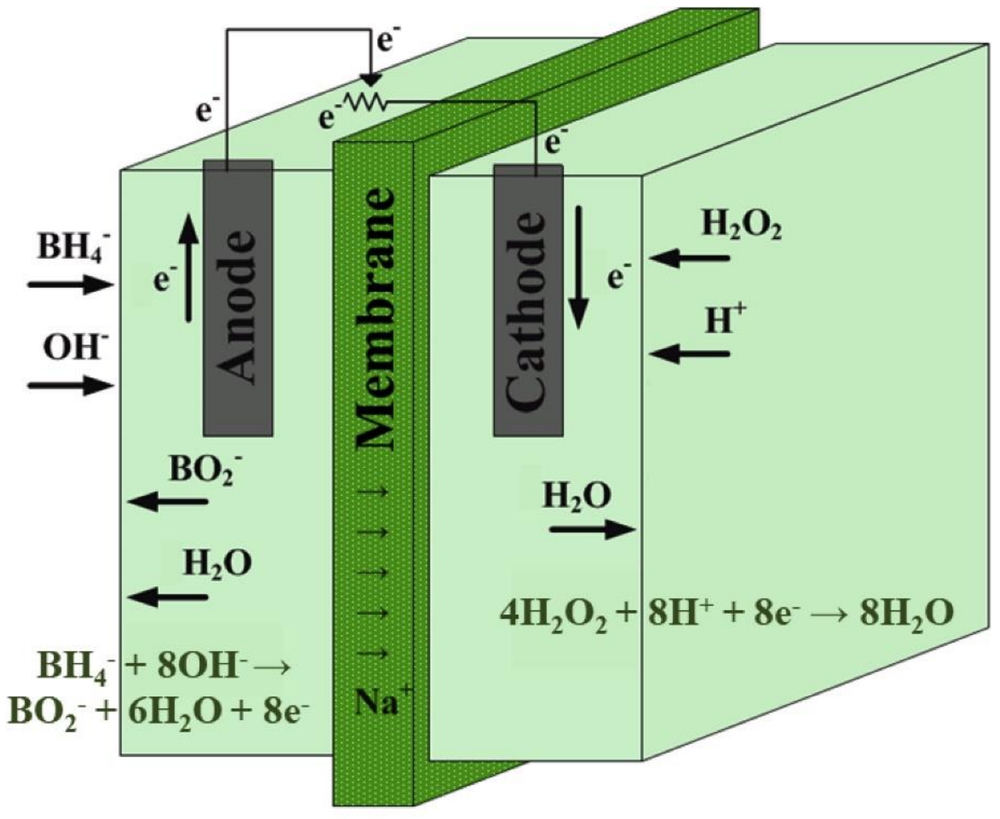

Fig. 1. Schematic illustration of a direct borohydride peroxide fuel cell (DBPFC).

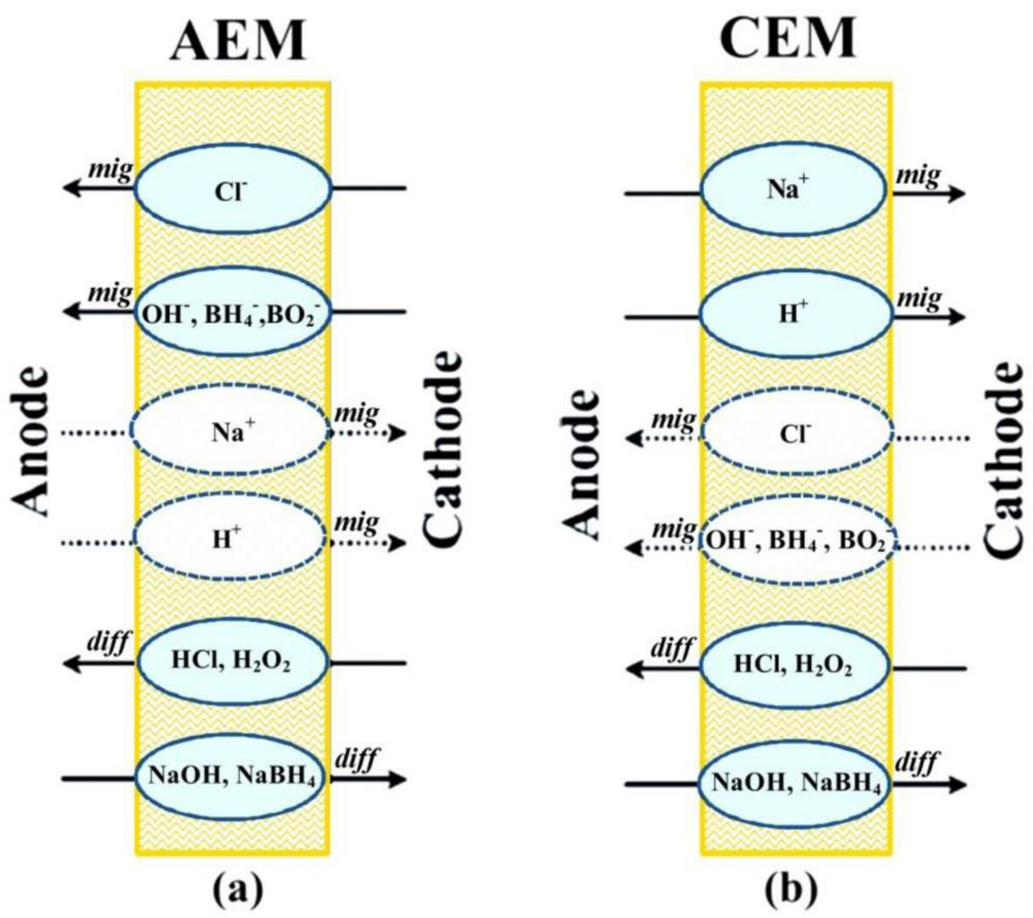

Fig. 2. Illustration of the major migrative (j_{mig}) and diffusive (j_{diff}) fluxes across (a) anion- and (b) cation-exchange membranes in DBFCs.

References

[1] B. Šljukić and D.M.F. Santos, "Direct borohydride fuel cells", in: "Direct Liquid Fuel Cells: Fundamentals, Advances and Future", 1st ed., R.G. Akay, A.B. Yurtcan (eds.), Academic Press, USA, pp. 203-232 (2021).

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