Influence of the cathodic membrane electrode assembly in a dual membrane electrolyser for the electrocatalytic reduction of O_2 to H_2O_2

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To enable cost-effective production of H_2O_2, electrocatalytic reduction of O_2 in a dual membrane electrolyser is proposed having porous solid polymer electrolyte (PSPE) sandwiched in between both membranes. This reactor configuration enables production of 'electrolyte-free' and concentrated H_2O_2, required for the main applications of H_2O_2. This research focusses on the cathodic membrane electrode assembly (gas diffusion layer pressed onto the anion exchange membrane (AEM)) and aims to elucidate the relevance of the electrocatalyst and type of AEM in the dual membrane electrolyser where O_2 is electrocatalytically reduced to H_2O_2.
Evaluation of commercially AEMs for the cathodic membrane electrode assembly was performed by stepwise increasing the electrical current of the electrolyser. Significant differences in cell voltages are obtained using different membranes (Fig. 1 left). The faradaic efficiency for H_2O_2 formation was ~90% at ≤100 mA/cm for all AEMs, however at >100 mA/cm the FE depends on the nature of the AEM (Fig. 1 right). These findings shows the impact of the nature of the AEM on the electrolytic process, moreover, the differences in cell voltage cannot be explained by solely the electric resistance differences between the AEMs. We therefore tentatively explain the obtained differences in cell voltage by differences in contact resistance, i.e. between the gas diffusion layer and the AEM, within the membrane electrode assembly. Furthermore, initial studies did not show a clear effect of the catalyst.

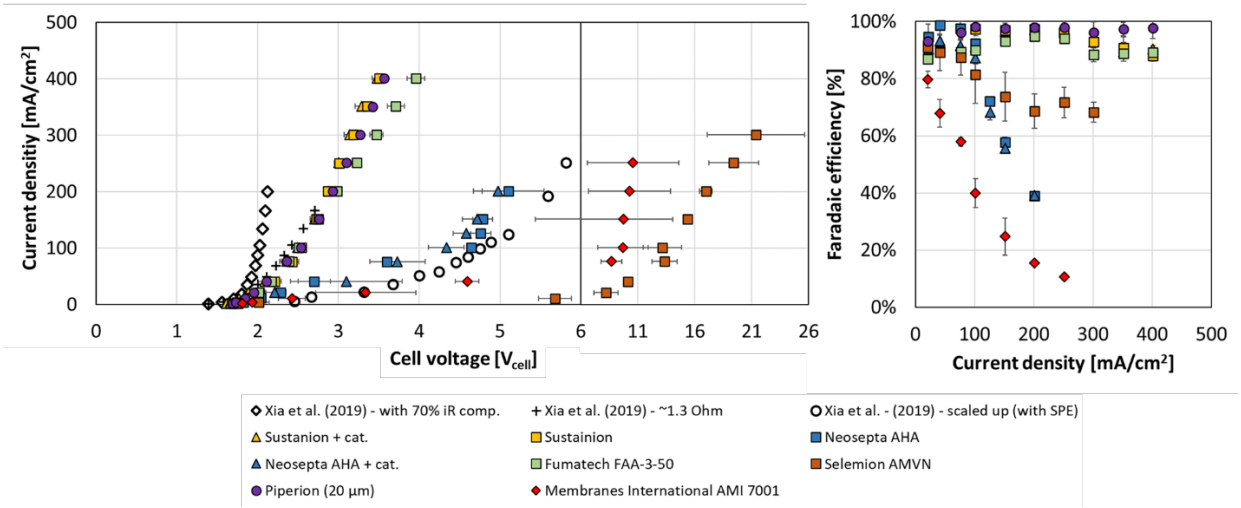

Figure 1. Cell potential and Faradaic efficiency for the $2e^-$ ORR to H_2O_2 using various AEMs, Nafion 117 as PEM, 0.5 M K_2SO_4 in the centre compartment and 1 M H_2SO_4 as anolyte.