

Comparative study of the HOR kinetics in PEMFC and AEMFC

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The recent development of anion exchange membranes (AEMs) stable over hundreds of hours [1, 2] will open a new and large window to the development of anion exchange membrane fuel cells (AEMFCs), if one refers to how findings on proton exchange membrane fuel cells (PEMFCs) increased following the discovery of Nafion® membranes. The major advantage of AEMFCs over PEMFCs is the possibility to finally get rid of the noble metal content in the electrodes, which actually takes $\approx 50\%$ of the total cost of a membrane electrode assembly for PEMFCs [3]. From an electrocatalysis view point, moving from an acid to an alkaline environment will open a lot of challenges for the H_2/O_2 electrodes. Similar to the focus that has been made over the last decades on understanding the mechanism of the oxygen reduction reaction and finding ways to reduce the total platinum content in the oxygen electrode, the advances on the hydrogen oxidation reaction (HOR) will play a pivotal role in the coming years on the development of AEMFCs.

From a fundamental view point, it has been proposed that the optimal catalyst for the HOR in alkaline medium should possess both active sites for the adsorption/dissociation of H_2 and for the adsorption of hydroxyl species, which may promote the HOR kinetics [4]. So far, possible candidates for the HOR in alkaline, which include platinum, palladium and iridium catalysts, have been evaluated in liquid electrolyte by means of rotating disk electrode (RDE) experiments [5-7]. However, for the most active HOR-catalysts the quantification of the reaction kinetics by such RDE measurements is limited by hydrogen diffusion, and the true HOR kinetics can be accessible only in fuel cell by performing H_2 -pump experiments [8].

With this limitation in mind, in this work we will provide a comparative study of the HOR kinetics for different catalysts (carbon supported platinum and palladium nanoparticles), as measured in AEMFC and PEMFC and also in liquid electrolyte by means of rotating disk electrode measurements. The main objective of this study will be to verify the validity of the following prediction: “The slow HOR kinetics are projected to cause significant anode potential losses in alkaline fuel cells for low platinum loadings ($> 130 \text{ mV}$ at $0.05 \text{ mg}_{\text{Pt}}/\text{cm}^2_{\text{anode}}$ and $1.5 \text{ A}/\text{cm}^2_{\text{geo}}$), contrary to what is reported for proton exchange membrane fuel cells” [7].

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