Improving Performance Stability of Anion-Exchange Membrane Fuel Cells

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A decade of intensive research work on Anion-Exchange Membrane Fuel Cells (AEMFCs) has finally yielded a high cell performance that is suitable for automotive applications. Thanks to the recent development of high-performance membranes, AEMFCs with power densities higher than 1 W cm^{-2} and limiting current densities above 4 A cm^{-2} have been reached [1-3], which seemed far from possible only a couple of years ago. In spite of this remarkable progress on cell performance, it is the low performance stability during cell operation what hampers further development and implementation of AEMFCs. As it has been recently reviewed, most of the AEMFC performance stability data are still limited to <1000 h [4].

One of the key reasons for limited cell performance stability is the chemical degradation of ionomeric materials under the severe fuel cell environment. The hydroxide anions transported from the cathode to the anode may attack the positively charged functional groups of the polymeric membrane (and ionomer), neutralizing part of it and suppressing its anion-conducting capability. This process may actually cause irreversible performance losses during cell operation. To address this challenge, several new stable ionomeric materials have been proposed, and while they perform well in ex-situ chemical stability studies, their performance is still limited in real operating fuel cells. Although cation chemistry dictates the intrinsic chemical stability of the anion-conducting ionomeric materials, it was recently shown that the hydration level at which the fuel cell operates significantly affects the chemical degradation [5-7]. This relationship between local cell hydration and ionomeric material degradation has been analyzed in modelling studies, providing further insights about the critical role of water on the performance stability [9].

This talk will discuss the relationship between water, membrane/ionomer degradation, and their impact on the AEMFC performance stability. A unique recently developed model capable of predicting the performance stability of AEMFCs will be also presented. By using membranes with achievable targeted properties, the model predicts an AEMFC life-time higher than 8000 h [9], suitable for automotive applications.

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