Performance evaluation in fuel cells – combined locally resolved in-situ diagnostic methods

Günther G. Scherer*, Ingo Schneider, Holger Kuhn,
Denis Kramer, Pierre Boillat, Alexander Wokaun
Labor für Elektrochemie
Paul Scherrer Institut,
CH-5232-Villigen, Schweiz
guenther.scherer@psi.ch

Recent demonstration projects have clearly indicated that the performance as well as the longevity of polymer electrolyte fuel cells (PEFCs) has to be improved to be competitive to conventional energy conversion devices. This requires a better understanding of the fundamental processes as well as their losses occurring in these cells, i.e., mass transport and electrochemical losses have to be minimized. Investigations have to be performed on cells having a size (active area) of technical relevance.
Electrochemical impedance spectroscopy yields information on elementary processes, e.g. charge transfer at interfaces as well as transport processes within the membrane-electrode-assembly and measures to minimize losses can be discussed [1]. Single electrode behavior at these particular interfaces in 1-dimensional cells can be investigated by the concept of a *pseudo reference electrode* into the "solid" electrolyte. These measurements allow the individual optimization of anode- and cathode/solid polymer electrolyte interface [2, 3]. Locally resolved impedance spectroscopy yields information on DC current distribution and the respective contributions to over-voltage losses in dependence of the mass flow direction of the reactants under varying humidification conditions [4, 5, 6].
The liquid water distribution in components of PEFCs can be visualized by Neutron Radiography [7, 8, 9]. In combination with locally resolved impedance measurements, the influence of mass flow onto the "local electrochemical activity" across the active area can be studied in dependence of the local (segmental) humidification conditions. Results from the application of these *in situ* diagnostic tools and combinations thereof to PEFCs [10] will be presented in this lecture.

References:

[1] B. Andreaus, G.G. Scherer, Solid State Ionics, 168 (2004) 311
[2] H. Kuhn, B. Andreaus, A. Wokaun, G.G. Scherer, Electrochim. Acta, 51 (2006) 1622
[3] H. Kuhn, A. Wokaun, G.G. Scherer, Electrochim. Acta, 52, (2007) 2322
[4] I.A. Schneider, H. Kuhn, A. Wokaun, G.G. Scherer, J. Electrochem. Soc., 152 (2005) A2092
[5] I.A. Schneider, H. Kuhn, A. Wokaun, G.G. Scherer, J. Electrochem.Soc., 152 (2005) A2383
[6] I.A. Schneider, S.A. Freunberger, D. Kramer. Wokaun, G.G. Scherer, J. Electrochem. Soc., 154, (2007) B383
[7] D. Kramer, J. Zhang, R. Shimoi, E. Lehmann, A. Wokaun, K. Shinohara, G.G. Scherer, Electrochim. Acta, 50 (2005) 2603
[8] D. Kramer, E. Lehmann, P. Vontobel, G. Frei, A. Wokaun, G.G. Scherer, NIMPR A 542 (2005) 52
[9] J. Zhang, D. Kramer, R. Shimoi, Y. Ono, E. Lehmann, A. Wokaun, K. Shinohara, G.G. Scherer Electrochim. Acta, 51, (2006) 2715
[10] I.A. Schneider, D. Kramer, A. Wokaun, G.G. Scherer, Electrochem. Commun., 7, (2005) 1393