A Microelectrode Study on the Interfacial Kinetics of Fuel Cell Reactions

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Alkaline anion membrane exchange (AAEM) fuel cell technology is a low-cost alternative to the depleting sources of fossil fuels. AAEM fuel cells operating at elevated pH values show improved electrode kinetics on non-precious metal catalysts, better water management and improved fuel crossover effects. However, the state of art AAEM fuel cells show low performance which is attributed to carbonate ion poisoning. In this study we have analyzed the effect of carbonate ions of the membrane, on the anode- membrane interfacial kinetics and on the transport of electroactive species through the membrane. A solid-state electrochemical cell employing a 100μm Pt microelectrode, Pt counter electrode and a dynamic hydrogen reference electrode was constructed in a controlled atmosphere to mimic the fuel cell anode-membrane interface. Two types of hydroxide-conducting membranes which mainly differed by the thickness, Tokuyama A201 and A901 were analyzed. The hydroxide ions in the membrane were exchanged with carbonate ions, and hydrogen oxidation reaction (HOR) and the methanol oxidation reaction (MOR) were carried out. Carbonate ions have a negative effect on the electrode reactions, lowering the pH of the anode reactions as well as by imposing blocking effect on molecule diffusion through the membrane. Both HOR and MOR reactions showed slow kinetics in the presence of carbonate ions. Carbonate ions strongly adsorb on to the electrode surface decreasing the hydroxide ions required for the reaction. Hydrogen diffusion through the membrane is not significantly affected by the presence of carbonate ions due the smaller size of the hydrogen molecule. However, hydrogen concentration in the membrane was drastically decreased. While methanol solubility in the membrane is minimally affected, the diffusion of bulky methanol molecules is greatly hindered by the carbonate ions.

Keywords: *Anion exchange membrane fuel cell, Hydrogen electro-oxidation, Methanol electro-oxidation, Methanol diffusion, Carbonate ion poisoning*