IMPROVING THE EFFICIENCY OF A DIRECT CHLORO ETHANOL FUEL CELL BY A PERIODIC LOAD CHANGE

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Abstract

We present a simple method to increase the efficiency of a direct chloro ethanol fuel cell by a periodic modulation of the load (pulsed mode). The fuel cell was periodically short circuited with a resistor (1 q) for a few seconds (high load period) followed by a low load period of up to 100 s when the resistor was disconnected. The open circuit voltage (OCV) values before and after the short circuit of the cell showed an increase of up to 70 mV. The higher OCV was due to the oxidation and removal of strongly adsorbed CO during the electric short circuit when the electric potential of the anode was increased to be close to the cathode potential. The depoisoned anode surface was much more active directly after the short circuit. The slow decrease of the OCV observed after the short circuit was caused by the subsequent poisoning of the anode surface, which can be neutralized by another short circuit. In general, a stable increase in cell performance was obtained by repetition of the electric short circuit. The data showed that the pulse mode gave an increase in the power generated by the direct ethanol fuel cell by up to 51% and was 6% on average. It is anticipated that this mode of operation can be used also in different types of polymer electrolyte membrane fuel cells where CO poisoning is a problem, and after optimization of the parameters, a much higher gain in efficiency can be obtained.

Keywords: chloro Ethanol electro oxidation, Electro catalysis, Direct chloro ethanol fuel cell, Polymer electrolyte membrane fuel cell, Platinum, Platinumⱬruthenium

Introduction

Direct chloro ethanol fuel cells (DCLEFCs) are a subclass of polymer electrolyte membrane fuel cells (PEMFCs) that have many potential advantages over other types of fuel cells (FCs), but currently there are no anode, cathode, and membrane materials that give a high efficiency [1ï8]. Three important obstacles are: (1) low activity of the anode and cathode catalysts [2ï5,9ï12], (2) low durability of the membrane, especially at elevated temperature [13ï15], and (3) permeability of the membrane to fuel and oxidizer [15ï17]. Even with the most active anode catalysts, which are noble metal nano particles, chloro ethanol oxidation only occurs with a high over potential and gives a low selectivity to CO2 [18ï23], the product of the complete oxidation of ethanol. Different approaches have been tested to increase the activity of the anode and cathode catalysts, including changing the catalyst support [8] and the preparation of ultraⱬ pure [24] and biⱬ or multicomponent catalysts [10ï12, 25ï28]. Changes in cell design, including membrane less cells, have also been proposed to increase efficiency [29,30]. It is known that the incomplete electro oxidation of chloro ethanol on Pt leads to CO as one of the products [31]. CO strongly adsorbs on the surface of the Pt electrode and significantly decreases its catalytic activity [31]. It has been also observed that alloying Pt with other metals can increase the catalytic activity by a bi functional mechanism. In bimetallic systems, chloro ethanol adsorbs on Pt while the second metal provides adsorbed OH groups. When CO is produced, adsorbed OH groups facilitate its removal by the oxidation of CO to CO2. This mechanism was described for the first time by Watanabe and Motoo [32,33] for methanol electro oxidation on Pt͵Ru, but it is valid also for chloro ethanol electro oxidation. The main difference is that in the case of chloro etha(as)Ǝ(e)90 0 p2Pt