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The main prerequisite of a liquid fuel for polymer electrolyte fuel cell applications is a high electrochemical reactivity at relatively low temperatures. Furthermore, the fuel should be reasonably cheap, non-toxic and largely available. At present, mainly methanol and natural gas are actively investigated as a alternative to hydrogen in fuel cells. Among other possible candidates, ethanol appears to fulfill many of the above requirements. Although the oxidation of ethanol to carbon dioxide requires the cleavage of the C-C bond, previous studies have shown interesting electrochemical reactivity at temperatures above 100 °C [1]. The main bulk products in the electrochemical oxidation of ethanol are CO_2, acetaldehyde and acetic acid. The latter determine low electrical energy yield and environmental problems. Such drawbacks are addressed by increasing fuel cell operating temperature and/or developing highly selective catalysts. Nanostructured materials such as nanosized catalysts and nanocomposite membranes offer unique properties for enhancing the performance of PEMFCs [2]. Since the state-of-the-art membranes dehydrate at temperatures above 100°C, new membranes, capable of sustaining higher temperatures (150°C), need to be developed. There are evidences that this drawback can be overcome by composite membranes including nanosized hygroscopic oxides dispersed in the polymeric matrix. An operating range for direct ethanol fuel cells (DEFC) between 110°C and 150°C appears suitable for distributed generation, whereas, for portable uses the maximum temperature should be not higher than 60 °C. A further severe problem for DEFCs is the fuel crossover through the membrane. This effect lowers the FC efficiency markedly. In the present work, an investigation of direct ethanol fuel cells based on composite polymer electrolytes for both low and high temperature applications is presented. The fuel cell systems have been studied in terms of performance, efficiency, cross-over and CO_2 yield. A significant increase of performance and electrical yield is achieved by operating the DEFC in the presence of composite membranes containing appropriate ceramic fillers. Furthermore, ethanol cross-over through the membrane is reduced by effect of an increase in tortuosity factor caused by the filler and ethanol consumption due to enhanced reaction kinetics at the anode-electrolyte interface.

References

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