High performance and durability of methanol fulled in-situ Ni-Cu alloying low-temperature solid oxide fuel cells

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Methanol is a promising fuel because of its portability and inhibiting coke by oxygen contents. The carbon formation is main problem to overcome degradation in operating dry methanol fuelled low-temperature solid oxide fuel cells (LT-SOFCs). In this study, new design of SOFCs was developed with high performance and highly coke tolerance. Methanol oxidizing catalyst, nickel copper alloy, was impregnated at the anode to enhance the coke resistivity and performance. Thin electrolyte increased the direct oxidizing methanol and coke radically by the fast oxygen ion transport. The schematic cell design was shown in figure 1. I-V curves and power densities of the reference cell (R-cell) and Cu impregnated cell (C-cell) with methanol fuel at 550 °C were shown in figure 2a. The OCV value of the R-cell, 0.85 V with methanol oxidation was almost same as the C-cell, 0.85 V. The ohmic overpotential of the R-cell in intermediate current range highly affected degrading the performance rather than the C-cell. I-V curve with a slight gradient led to emit a high current density and consequently induced increasing maximum power density in the C-cell. However, methanol fuelled R-cell and C-cell had voltage loss by concentration polarization at 550 °C unlike hydrogen fuelled. It could have prospect to enhance the performance when the support has macro-pores attached to dense electrolyte. These were shown in impedance spectra, figure 2b. Based on the reported LSCF cathode with oxygen reduction reactions and characteristic frequency of impedance arcs, [1-3] the gas diffusion in anode was congenial cause to the low summit frequency of 7.68 Hz. Both of the impedance spectra with methanol shows that diffusion resistance affects significantly compared to the hydrogen used as the fuel. The results of the constant current mode at 1.4 A cm^{-2} with the methanol fuel at 550 °C shows in figure 2c. Initial values of voltage were similar about 0.6 V at both of the cells. It was found that the voltage dropped rapidly after 17 h to 20 h. However, the C-cell had stable voltage value for 60 h which indicates the coke problem can be solved by this cell construction.

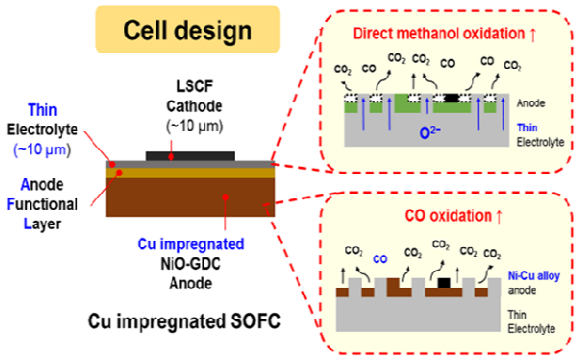

Fig.1 The schematic design of improved SOFCs with use of methanol fuel.

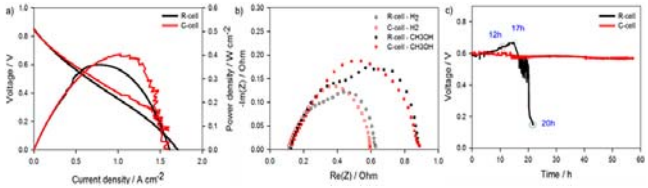

Fig. 2 (a) I-V curves, performance, (b) impedance spectra and (c) long-term constant current mode test at 1.4 A cm^{-2} of the Cu impregnated cell and reference cell at 550 °C with methanol fuel.

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