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Development of tubular type direct carbon fuel cells

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Direct carbon fuel cells (DCFC) are fuel cells utilizing solid carbon as fuel. The total reaction is expressed by the following equation. C(s) + O2(g) = CO2(g). Coal, biomass and waste can be used as fuel for DCFC. DCFC is expected to have high electric power generation efficiency and be a compact device. Easy storage and transportation of fuel are possible due to utilizing solid fuel. One of the big problems for DCFC has been how to continuously supply solid carbon to the electrode surface. To solve this problem, we proposed a novel DCFC system using tubular type cells. This study investigated the basic characteristics of tubular type DCFC. We already developed tubular type molten carbonate fuel cells (TMCFC), and it was applied for DCFC cells in this study. Each electrode materials were formed by a slurry coating method. The cathode was NiO-3%MgO, electrolyte matrix was LiAlO2, the anode was Ni-2%AlCr (+10%Al2O3) and the electrolyte was 60%Li2CO3-40%Na2CO3 molten salt. A tubular cell was inserted into the mixture of activated carbon and molten carbonate (carbon: carbonate = 8:2 wt %). A continuous power generation test and I-V measurement were conducted. Continuous power generation was achieved for 100 mA cm-2 for 24 hours at 800°C. The anode outlet gas composition was measured during the test. CO was 11.2% and CO2 was 1.2%. Most of the CO2 generated by anode reaction was presumed to react with carbon and changed to CO by Boudouard reaction. The result of I-V measurement at 700-850 °C showed that the cell performance of DCFC is better at a higher temperature. This study found that tubular DCFC is able to generate high electric power and is useful for the effective utilization of carbon resources.

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