Development of 1kW direct methanol fuel cell stack for portable power sources

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The direct methanol fuel cell (DMFC) is considered to be a promising power source for portable devices, leisure facilities, laptop computers, and light-duty vehicles because of its easy transportation and storage of methanol fuel, simple system components, and high energy density of methanol. In this study, the operating characteristics of 1kW class DMFC stacks and power-pack system was investigated using a 80-cell stack, power convertor, system controller, and system components.

In order to prepare a catalyst slurry, the catalyst powder (60% PtRu/C and 60% Pt/C), deionized water and Nafion solution (10 wt%), DuPont) were mixed with isopropyl alcohol and the Nafion ionomer in both side were added. The catalyst slurry was coated on the gas diffusion layers using semi-automatic bar coating machine. The catalyst loading was 1.8 and 2mg/cm² for the anode and cathode.

Fig. 1 shows the polarization curve and power of the DMFC stack. The performance of the stack was investigated in a test station. The DMFC stack (200 x 132 x 270 mm (W x H x L), 10kg, 7.13L) was tested for supplying of the power and charging of the battery in a camping trailer. A solution of 0.6M methanol was fed to the anode and air was introduced to the cathode under ambient pressure. The stack has a nominal power output of 1245W (32V at 38.9 A) at operating temperature of 61°C. The DMFC system has stable operating characteristics and provides an output power of 1 kW.

Fig. 1. I-V curve and power of 1kW stack at 61°C.

Fig. 2 shows the results of the long-term test (512 h) on the DMFC stack. This test was performed at a constant current of 32 A. The external electricity failed two times during the long-term operation, as indicated in Fig. 2. The results show that even though the DMFC stack is operated in high current densities between 32-33A, it maintains a high performance above 1081 W for more than 500 h.

Fig. 3 shows the I-V curve and power of 1kW stack before and after long-term test (512h). At the beginning of the test, the stack has 240W (32V at 38.8 A) of power and the performance is maintained for 512 h; the power then drops to 1200 W. This performance decline is possibly caused by the reduction of the active surface area and poisoning of the MEA components.

Dynamic response of DMFC stack was examined using a stepwise increasing current mode. The stack shows the uniform voltage distribution and the stable power.

Fig. 4. Changes of stack voltage and power in dependent on the current roads of 1kW stack.

A 1kW class DMFC stack with 80-cell was developed for power-pack system. The stack has a nominal power output of 1245W (32V at 38.9 A). The stack shows the uniform voltage distribution and the stable power. The DMFC system has stable operating characteristics and provides an output power of 1 kW.

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