Hydrogen production by Solid Oxide Electrolysis Cells assisted with low calorie gas

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Introduction

Hydrogen is expected one of main secondary energies in the near future. Especially, for the fuel cell that is clean power generation equipment, establishment of hydrogen production technology is needed. The water electrolysis, and steam electrolysis, which can produce pure hydrogen, needs much electricity. In order to solve such problem, it is possible to reduce electrolysis voltage by introducing low calorie gas to a cathode side.

In this study, the steam electrolysis by using Solid Oxide Electrolysis Cells (SOECs) assisted with low calorie gas was studied. The measurements were made by using a high accuracy of gas analyze system.

Experiment

Tubular SOECs were fabricated by using the ceramics wet process. The raw materials, thickness of each layer forming the testing cells are shown in Table 1. 8YSZ, 10ScSZ denote 8mol% yttria stabilized zirconia powder and 10mol% scandia 1mol% ceria stabilized zirconia powder. Figure 1 shows experimental flow diagram. The testing cell is connected to ceramics tube and set in an electric furnace. The SOECs were sealed by the homemade glass paste.

Component and flow rate of exhaust gas from the cathode was analyzed by FTIR and QMS. The FTIR and the inlet of the QMS were kept 170~180℃ to avoid condensation of steam.

Slight humidified hydrogen diluted by nitrogen was supplied to the anode to simulate the low calorie gas.

Results and discussion

The performance of the cell at 700℃ is shown in Figure 2. Because that the concentrations of hydrogen in the cathode gas and the anode were 48% and 80%respectively, the open circuit voltage is –0.14V.

This means that the SOECs assisted by low calorie gases produce electricity as well as hydrogen under the low fuel utilization or the low steam utilization.

The product rate hydrogen is good agreement with the calculated value from the applied current to the cell . It denotes that the current efficiency is 100% and the gas leakage from the cell assembly is negligible.

Testing cell operated at 700℃ produce hydrogen at very low electric voltage from –0.2V to 0.2V.

The cell performance deteriorates rapidly at the voltage higher than 0.2V and once the degradation occurs, even if the electrolytic voltage was reduced, the cell performance degradation was not recovered.

Research decreasing this degradation for increasing cell performance is undergoing is conference result of these research will be reported too.

Table 1. Testing cells

	Material	Thickness	Fabrication method
Support tube	NiO, 8YSZ (6:4)	1mm	Tape casting
Cathode	NiO,10ScSZ(6:4)	~10μm	Slurry coating
Electrolyte	10SSZ	10~20 μm	Slurry coating
Anode	NiO,10ScSZ(6:4)	10~50 μm	Slurry coating

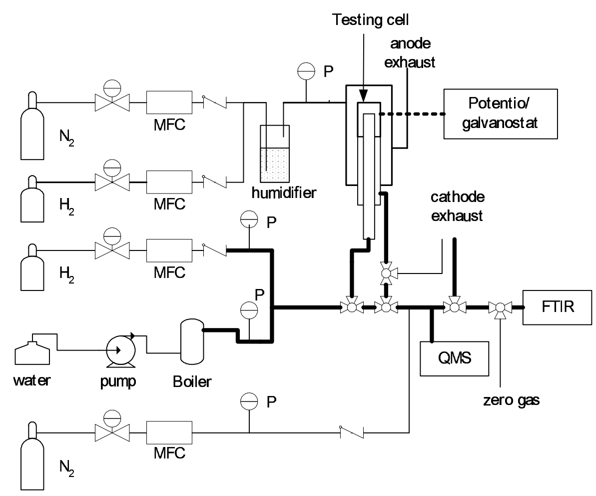

Figure 1. The experimental flow diagram

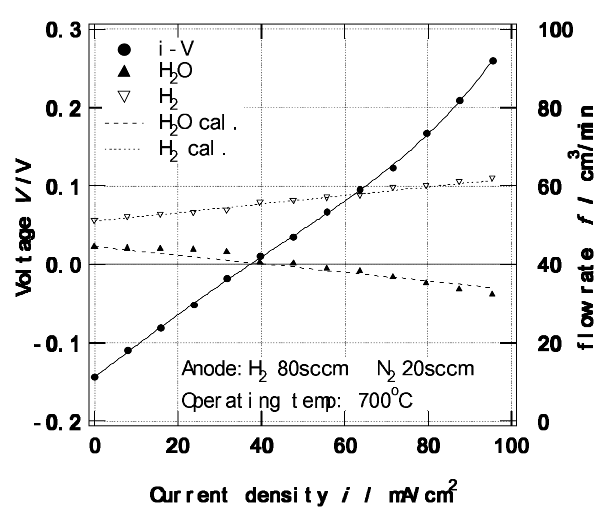

Figure 2. dependence of electrolytic voltage,hydrogen and steam flow rates at the outlet of the cathode on current at 700℃ of a testing cell.