

Performance of YSZ-supported Anode for SOFC Substrates

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Introduction-Anode-supported type solid oxide fuel cells (SOFC) have higher performance of its electric power generation property and longer term stability than that of the electrolyte-supported one (1). YSZ-supported anodes with a novel microstructure realized by YSZ framework consisting of coarse and fine powders have been also found to have a long term stability (2).

In this paper, experimental results are discussed concerning the changes in the dimensional stability for the anode substrates under cell operation atmospheres. To compare and clarify the electric power generation properties, three single cells using respective three kinds of the YSZ-supported anodes were prepared. The characteristics of current density-cell voltage for them were measured.

Experimental-The anodes were used to examine in this study, which are 4-6-1, 4-6-2 and 5-5-1, expressed by the weight ratio in the form, x-y-z, for the coarse YSZ, the NiO and the fine YSZ, respectively. Preparation process of them is described in Ref. (2).

For the reduction tests and application to the substrates of the anode-supported type single cells, the anode powders were molded into a pellet and then sintered at 1673 K. YSZ electrolyte for the single cells was slurry-coated and fired at 1673 K onto the anode substrate several times. Cathode of the lanthanum manganite powder added terpeneol were coated and baked at 1423 K on the YSZ layer with an electrode area of 3.1 cm². In tests of the power generation properties at around 1273 K, gaseous H₂ humidified by water at 293 K as a fuel and air as an oxidant were supplied to the anode and the cathode, respectively. The polished cross sections of the cells were observed with an electron probe micro-analyzer.

Results and discussion-Reduction test was carried out to clarify both the changes in porosities and shrinkages for the anode substrates. During the initial 50 h, all samples

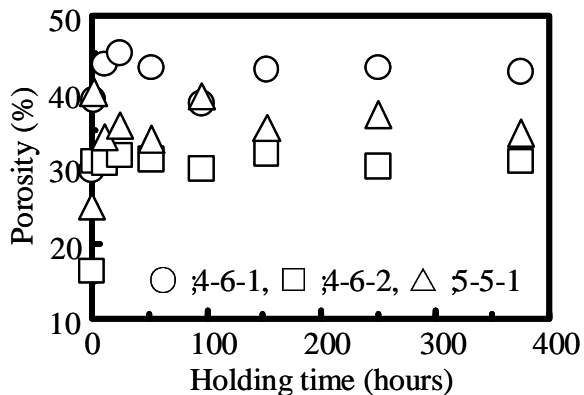


Fig. 1 Change in porosity for the anode substrates under the experimental conditions.

showed large initial increase in porosity without remarkable linear shrinkage, and then became constant over time, as shown in Fig. 1. These phenomena would be accompanied by reduction in NiO to Ni with a simultaneous decrease in the volume and a strong agglomeration of Ni particles. However, all samples did not show any changes after the initial increment due to stable framework by both the coarse and fine YSZ. It is found that porosity for the 4-6-2 anodes is the smallest, that is under 35.0 %, because of the highest fine YSZ contents all of the anodes in this study.

The polished cross section of the single cell using the 4-6-1 anode substrate after the performance test is shown in Fig. 2. It was confirmed that the YSZ layer with some closed pores was about 10 μm in thickness, and that its microstructure of the anode substrate was similar to our previous studies (2).

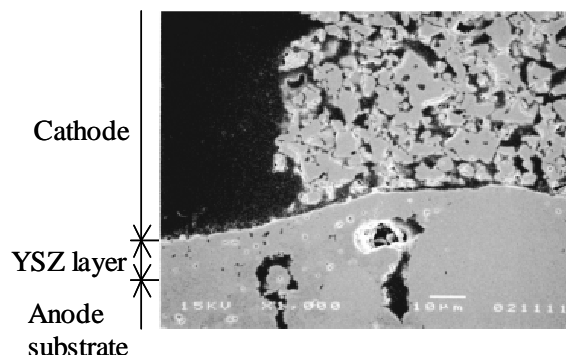


Fig. 2 The microstructure of single cell using the 4-6-1 anode after performance test.

Figure 3 shows characteristics of current density-cell voltage for the respective single cells in an operation condition for about 50 hours. Their open circuit voltages were attained to theoretical value (about 1.04 V), therefore it is seemed that the YSZ electrolyte is formed into gas-tight layer. The cells with the 4-6-1 and/or 5-5-1 anode substrates reached approximately 1.60 A/cm² of the current density at 0.60 V of the cell voltage, and are higher than that with the 4-6-2 one. It would be considered that the electric power generation property of the anode supported SOFC was affected by porosity of the anode substrate; that is a threshold at around 35 % in porosity.

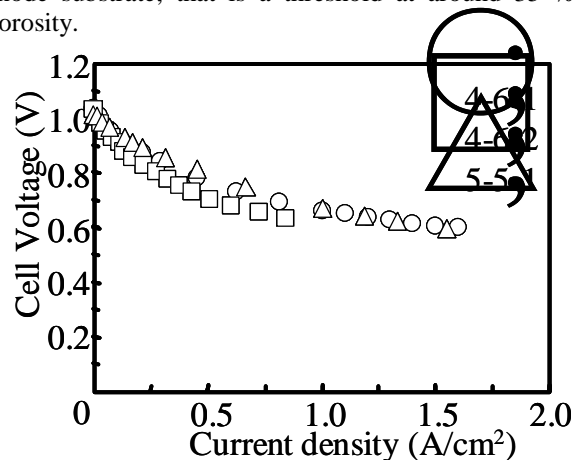


Fig.3 Current density – cell voltage characteristics of the single cells at around 1273K. (Electrode area = 3.1 cm², Q_{H₂(+H₂O)} = 300 cm³/min, Q_{air} = 1000 cm³/min)

References

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- (2) H. Itoh et al., *J. Electrochem. Soc.*, **144**, 641 (1997)