FABRICATION AND CHARACTERISTICS OF ANODE-SUPPORTED FLAT TUBULAR SOFC

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INTRODUCTION

Anode-supported SOFC may be one of candidates for the intermediate temperature SOFCs. For development of an anode-supported tubular type SOFC with high mechanical strength, large area and high performance, we have worked the manufacturing process and cell performance of cylindrical anode-supported tube cell with gastight electrolyte layer and with variations of cathode layer, reported in the previous works [1-4].

In this work, we developed anode-supported flat tube cell to improve the power density of the cylindrical tube cell and studied basic technology of key components in flat tube SOFCs such as electrode, electrolyte, ceramic interconnect materials, and metallic interconnect materials as a current collector. Their characteristics were evaluated and anode supported flat-tube cell stack was newly designed and fabricated.

EXPERIMENTAL

The extruded flat anode-supported tube was served as fuel electrode and the other cell components were coated in the form of thin layers onto it. The 40 vol.% Ni –YSZ (8 mol% Y_2O_3-stabilized ZrO_2) anode powder were prepared by mixing 8 mol % yttria stabilized zirconia (TZ-8Y, Tosoh co.) and nickel oxide (NiO, Junsei chemical co.) powders. Anode powder and activated carbon as pore former were weighed, mixed in ethanol and then dried. Organic binder and 25 wt.% distilled water were added to the dried powder, and then the well-dispersed paste was extruded in the form of flat-tube. The extruded flat-tubes were dried in microwave and aged in the drying oven, followed by presintering process at 1300 ℃. The YSZ electrolyte layer was coated on the presintered anode tube by slurry dip process to form a dense layer and cofired at 1400℃. Mixture of LSM ($(La_{0.85},Sr_{0.15})_{0.9}MnO_3$) and YSZ, LSM and LSCF ($La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_3$) for multilayered cathode were coated subsequently onto the co-sintered flat-tube substrate by slurry dip process and sintered at 1200℃. Performance characteristics of single cell was evaluated at 750℃ in humidified hydrogen with 3 % H_2O and air. By using the flat tube cells, we designed and fabricated the anode-supported flat tube stack with metallic interconnect.

Fe-16Cr (SUS 430) alloys as metallic interconnect were dip-coated in the LSM ($(La_{0.85}Sr_{0.15})_{0.9MnO3}$) slurry and sintered at 1200 ℃ for 2 h in the different atmosphere (Air and Ar+10 % H_2). $La_{0.75}Ca_{0.27}CrO_3$ as electrical interconnections in anode supported flat-tube cell was coated into the anode support by plasma spray coating. The characteristics of coating layer were examined in comparison with slurry coating.

RESULTS AND DISSCUSION

Anode-supported flat tube solid oxide fuel cell was fabricated to increase the cell power density and thermal stability by combining the merits of tubular and planar type cell structure. The porosity and pore of the flat anode tube were 50.6 % and 0.23 ㎛, respectively. The Ni particles distributed uniformly and connected well in the cermet. YSZ electrolyte layer with gas tightness was produced by slurry dipping process. The anode supported flat-tube cell showed cell performance of 225 mW/cm^2 (0.6V, 375 mA/cm^2) and operated for 300 hrs without degradation in cell performance. As ceramic interconnect for flat-tube cell stack, $La_{0.75}Ca_{0.27}CrO_3$ was synthesized by Pechini method and coated onto the anode substrate in the form of narrow band by plasma spray. The dense ceramic interconnection layer was obtained. Fe-16Cr alloy coated with LSM as metallic interconnector indicated good sinterability in Ar+10 % H_2 atmosphere, which had areal specific resistance of 148 mΩ cm^2 at 750 ℃ in air condition and lowered to 43 mΩ cm^2 after 450hrs.

We obtained basic technology for anode-supported flat tubular cell through the present works. By using the flat tube cells, we designed and fabricated the anode-supported flat tube stack with high power density. Its cell stack will be tested.

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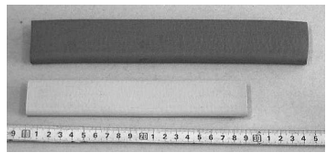
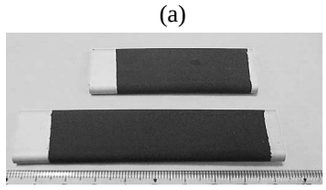


(a)



(b)

Fig.1 The photos of (a) as-extruded and presintered anode-supported flat tube, (b) anode-supported flat tube cell.