CELL PROPERTIES OF SOFC PREPARED BY DOCTOR BLADE AND SCREEN PRINTING METHOD

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ABSTRACT

In order to reduce production costs, we have fabricated single solid oxide fuel cell by doctor blade and screen printing method. Disk-type planar SOFC with an effective electrode area of about 7 cm² were fabricated and run for 510h to investigate cell performance. The current density at a voltage of 0.7 V was 850 mA/cm².

INTRODUCTION

Planar solid oxide fuel cell have been widely studied by many researchers because of high efficiencies and a convenient manufacturing process. Doctor blade method have provide the interesting possibility of developing stack of SOFC which consist of an electrolyte, two electrodes and interconnection.

KERI has been developing disk type planar solid oxide fuel cell which allow the high performance. In this paper, we concentrate on the development of manufacturing methods for electrolyte, anode and cathode.

EXPERIMENTAL

A summary of the starting powders for cathode sample is
shown in Table 1. Figure 1 shows the manufacturing process for the cathode powder by citrate method. Figure 2 shows the manufacturing process for the anode powder.

Single cells were fabricated using conventional thick film processing techniques, i.e., doctor blade and screen printing. We could make disk-type planar SOFC single cells about 7 cm size, using a 8 mol% YSZ electrolyte, perovskite type cathode, and Ni-YSZ cermet anode.

As cathode material, lanthanum-strontium-manganese perovskite (LSM) of optimized La0.7Sr0.3MnO3 composition was used because of its high electric conductivity and good compatibility with the electrolyte, consisting of zirconia doped with 8 mol% yttria (8YSZ).

A schematic diagram of the electrolyte fabrication is shown in Figure 3. Figure 4 shows doctor blade machine. In this fabrication process, electrolyte sheets are first fabricated by doctor blade method.

Anode and cathode slurries were screen printed onto dense YSZ electrolytes and fired at 1400 and 1200 °C, respectively. Figure 5 shows schematic diagram of a single cell.

**RESULTS AND DISCUSSION**

Figure 6 shows typical I-V characteristics for a single cell.

It generated a maximum electric power of 5.2 W at 1000 °C with hydrogen and oxygen gas. The current density at a voltage of 0.7 V was 850 mA/cm².

The good I-V characteristics imply that both the anode (Ni-YSZ) and cathode (La0.7Sr0.3MnO3) materials are suitable.

Figure 7 shows performance comparison of a doctor bladed cell with that of a cold pressed cell.

Figure 8 shows a photograph of the configuration of a single cell, which consisted of an electrolyte, anode and cathode.
Figure 9 shows the cell holder. The cell holders were made of a heat resistant alloy (Inconel 600), and were used as current collectors and gas manifolds.

The endurance of a single cell was evaluated by operating it for more than 510 hours. After measuring various characteristics, the single cell was operated at a constant current density of 150 mA/cm².

Table 2 shows the cell performance according to the electrolyte manufacturing process.

**CONCLUSIONS**

The single cell of which the components were made by doctor blade and screen printing method, was found suitable in performance.

The single cell performance consisted of a cell open circuit voltage of 1.15V, a cell voltage of 0.97V at 0.15 mA/cm² using H₂/O₂, and a cell maximum output of 0.85 W/cm². And, the single cell was operated for over 510 hours.

**REFERENCES**

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Fig. 1 Manufacturing process of cathode powder by citrate method.
NiO powder

← alcohol

Ball mill
(24hr)

← YSZ

Ball mill
(24hr)

Drying

Calcination
(1400°C, 2hr)

Grinding

Fig. 2 Manufacturing process of anode powder.
Fig. 3 Manufacturing process of electrolyte.
Fig. 4 Doctor Blade machine.

- Cathode (100μm)
- Electrolyte (300μm)
- Anode (110μm)

Fig. 5 Schematic diagram of a single cell.
Table 1  Materials for cathode sample.

| Reagent            | Structure          | Molecular Weight | Company            |
|--------------------|--------------------|------------------|--------------------|
| Lanthanum Nitrate  | La(NO₃)₃ • 6H₂O    | 433.03           | GFS Chemicals     |
| Strontium Nitrate, Anhydrous | Sr(NO₃)₂ | 211.63           | Junsei Chem. Co.   |
| Manganese Nitrate  | Mn(NO₃)₂ • nH₂O   | Mn(NO₃)₂=178.95   |                   |
| Citric Acid        | C₆H₈O₇ • H₂O      | 210.14           | Oriental Chem. Ind.|

Fig.6  I-V performance of single cell for SOFC. (La₀.₇Sr₀.₃MnO₃/8YSZ/50Ni-YSZ,H₂/O₂ = 700/800cc/m)
Fig. 7 Performance comparison of doctor blading cell with cold pressing cell.
(\(\text{La}_0.7\text{Sr}_0.3\text{MnO}_3/\text{8YSZ/50Ni-YSZ}\))

Table 2 Performance according to electrolyte manufacturing process.

| Manufacturing process of electrolyte | Cold pressing | Tape casting |
|-------------------------------------|--------------|-------------|
| Thickness                           | 2mm          | 300\(\mu\)m |
| Anode                              | 50Ni-YSZ     | 50Ni-YSZ    |
| Cathode                            | LSM0.3       | LSM0.3      |
| Current density (at 0.7V)           | 275mA/cm\(^2\) | 850mA/cm\(^2\) |
| Max. power density                 | 0.21W/cm\(^2\) | 0.85W/cm\(^2\) |
Fig. 8 Single cell of Disk type planar SOFC.

Fig. 9 Cell holder of Disk type planar SOFC.