APPLICATION OF $LaNi(Fe)O_3$ AS AIR ELECTRODE OF SOLID OXIDE FUEL CELLS

Himeko Orui, Kimitaka Watanabe and
Masayasu Arakawa

NTT Energy and Environment Systems Laboratories,
3-1, Morinosato-wakamiya, Atsugi-shi,
Kanagawa, 243-0198, Japan

INTRODUCTION

Reducing the SOFC operating temperature to under 800 °C is required in order to make SOFCs practical. To reduce the operating temperature, an anode- (or cathode-) supported cell, which enables to reduce the electrolyte thickness, has often been applied [1], and various high-conductivity materials for low-temperature operation have been investigated. We have proposed Sc_2O_3- and Al_2O_3-stabilized ZrO_2 (SASZ) for the electrolyte and $LaNi(Fe)O_3$ (LNF) for the cathode material [2, 3]. We fabricated anode-supported cells by co-firing of NiO-SASZ anode and SASZ electrolyte and the LNF was applied to the cathode. However, it has been found that the LNF reacts with the YSZ, resulting in the formation of a $La_2Zr_2O_7$ phase over 1100 °C [4]. In this work, the LNF sintering condition was studied to optimize cell performance, and the relationship between LNF sintering temperature and its reactivity with SASZ was examined.

EXPERIMENTAL

Half-cells consisting of anode substrate and electrolyte were fabricated by the co-firing method. Ten mol% Sc_2O_3-and 1 mol% Al_2O_3- stabilized ZrO_2 (SASZ) is used for the electrolyte. The mixture of 60 wt% NiO and 40 wt% SASZ is used for the anode. $LaNi_{0.6}Fe_{0.4}O_3$ (LNF) is used for the cathode. The anode and electrolyte green sheets were prepared by the doctor blade method, and they were laminated and co-fired at 1300 °C. The cathodes were tape-cast on the electrolyte and fired at several temperatures between 800 ～ 1200 °C. The LNF sintering characteristic was measured with a dilatometer (Mac science co. DILATOMETER 5000). In order to estimate the reactivity of cathode and electrolyte, the mixtures of LNF and SASZ were sintered at 800 ～ 1100 °C and the crystal structure was analyzed by X-ray diffraction (XRD). The microstructures of the cells were characterized by scanning electron microscopy (SEM). The current-voltage characteristics were measured using 250 ml/min of air and 100 ml /min of H_2 for the oxidant and fuel, respectively. Before measuring the current-voltage characteristics, cells were operated at constant current, and current was stepped up while keeping the cell voltage at around 0.2V. We call this procedure the constant current operating (CCO) treatment. Electrochemical characteristics were investigated by AC-impedance measurements at around the open circuit voltage (OCV) to obtain more detailed information about the internal resistance of the cells.

RESULTS AND DISCUSSIONS

The relation between LNF sintering temperature and the reactivity with the SASZ was investigated. LNF should be sintered above 1000 °C to make good contact on the electrolyte. On the other hand, the XRD pattern revealed the $La_2Zr_2O_7$ phase in the sample sintered over 1000 °C, and the intensity of $La_2Zr_2O_7$ peak increased with temperature. To investigate the influence of the LNF sintering temperature on the internal resistance of cells, the AC- impedance was measured using cells with LNF sintered at several temperatures. Every spectrum of the cells consists of mainly two arcs, one of several thousand Hz and the other of several Hz, as shown in Fig. 1. The diameters of the high-frequency arcs, which correspond to the cathode reaction resistance [5], are largely influenced by the LNF sintering temperature and show the minimum value at 1000 °C. The AC-impedance spectrum after CCO treatment is also shown in Fig. 1. The total resistance of the cell was decreased by the CCO treatment, especially the ohmic resistance and cathode reaction resistance. Figure 2 shows the LNF sintering temperature dependence of power density at 0.7 V when cells were operated at 800 °C. The maximum value of 1.33 W / cm^2 is obtained in the cells sintered at 1000 °C. These results demonstrate that the LNF/SASZ system is a promising way to make practical SOFCs.

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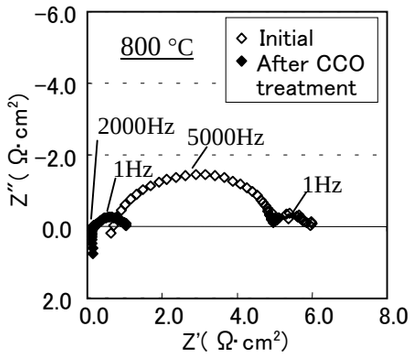

Fig. 1 AC impedance spectra of the cell with the LNF sintered at 1100 °C.

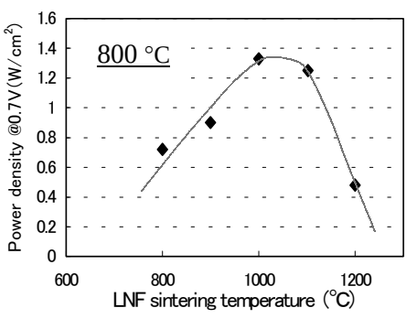

Fig. 2 Dependence of the power density on LNF sintering temperature.