Characterization of Porous Thin-film LSCF Cathode for Low-temperature Operating μ-SOFC Prepared by Spray Pyrolysis Deposition

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Introduction

For many potential mobile robot applications, current power supply technology (such as the lithium ion battery technology) is in fact a key limiting factor due to its low energy density. Solid oxide fuel cells (SOFC) is a promising alternative and can overcome limitations of current battery technology. Especially, μ-SOFC with thin film electrolyte[1,2)] is promising due to lower ohmic resistance.

Cathode electrode should have large specific surface area for small resistance. That is, cathode electrode should be porous with fine crystal grains. However, it was difficult to prevent the crystal grain growth when using a conventional ceramic process that requires high temperature sintering. $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_{3-\delta}$ (LSCF) is the one of the most promising cathode material because LSCF has a high ionic and electronic conductivity, and fast oxygen surface exchange[3,4)].

Spray pyrolysis deposition (SPD) is a film formation technique by spraying precursor solution onto a heated substrate[5)]. SPD enables us to fabricate complex oxide of uniform composition in low temperature. Furthermore, not only dense film but also porous film can be obtained by controlling the depositing condition, such as the concentration of the precursor solution.

The objective of this research is to demonstrate a porous LSCF thin film with fine grains by SPD.

Thin film preparation

Precursor solutions were prepared by dissolving $La(NO_3)_3 \cdot 6H_2O$, $Sr(NO_3)_2$, $Co(NO_3)_2 \cdot 6H_2O$ and $Fe(NO_3)_3 \cdot 9H_2O$ into dilute nitric acid at cation concentration of 0.10 mol/l and 1.0 mol/l. Substrate temperature was controlled at 350 ^{o}C. Post annealing was conducted at the temperature range of 700 ^{o}C and 1000 ^{o}C for 1 h in air.

Characterization

Figure 1 shows the XRD spectra of the thin film as depositing/ after annealing. The many peaks of the precursor and LSGM, which was used as substrate, were observed in the XRD spectra as depositing. By annealing, precursors turned into the perovskite LSCF. LSCF cathode was successfully fabricated by SPD.

Figure 2 shows the surface SEM image of the LSCF cathode. LSCF cathode was porous with fine grains. The grains were approximately 0.3 μm in diameter.

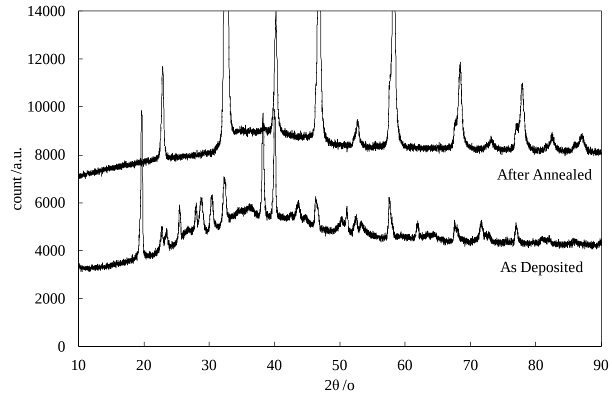

Figure 1. XRD spectra of thin films prepared using the precursor solution of 1.0 mol/l. (lower; as SPD, upper; after post annealing)

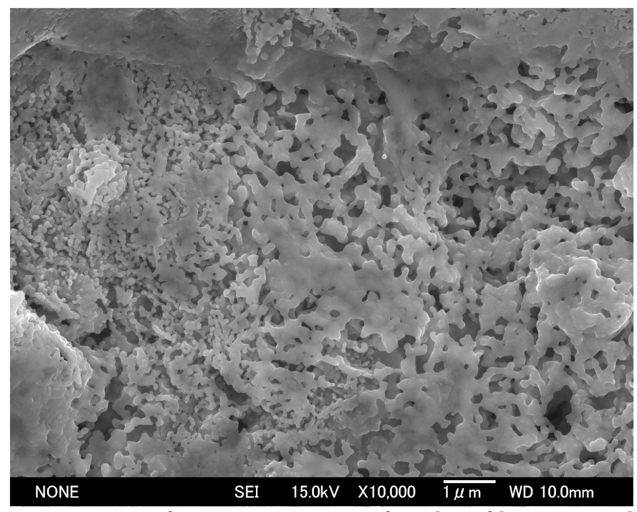

Figure 2. Surface SEM image of a thin film prepared using the precursor solution of 1.0 mol/l.

References

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