OXYGEN DIFFUSION OF NON-STOICHIOMETRIC (La, Sr)MnO_{3-d} /CERIA NANO-COMPOSITE SOFC CATHODE

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Solid oxide fuel cell (SOFC) is one of the highly efficient energy generation system, and it requires higher power density per unit volume to expand SOFC stationary market as well as vehicle. Co-sintering of stacks or cells including electrodes, electrolyte and separators is most promising approach to improve the power density significantly. Generally, cathode materials have low heat resistant temperatures, and they were easily decomposed or degraded by sintering at a high temperature which is suitable for densification of SOFC electrolytes. Cathode material of $(La_{1-x}Sr_x)_{1-y}MnO_3$ (LSM) shows relatively highly heat resistance and preferable low-reactivity with fluorite electrolytes during sintering at high temperatures. The addition of LSM also much increased degradation temperature. However, it shows lower cathodic properties than lanthanum strontium cobaltite and lanthanum strontium cobalt ferrite because of poor oxygen ionic conduction. We thus investigate LSM/ceria nanocomposite cathode materials to improve oxygen ionic conduction.

The nanocomposite precursor powder containing LSM and lanthanum doped ceria (LDC) was synthesized by glycine method. Two stoichiometric compositions, which are stoichiometric composition (y=0) and non-stoichiometric (y=0.05), were prepared as LSM, and LDCs that were dissolved with lanthanum at various ratios were used to investigate inter-diffusion of lanthanum between LSM and LDC. The composite ratio of LSM and CeO_2 was fixed at 9: 1 (molar ratio). Figure 1 shows SEM image of LSM/LDC nanocomposite sintered at 1200^oC for 5 h in air. Sintering at 1200^oC for 5h resulted in dense composite, and fine LDC particles were homogeneously dispersed with LSM. Lanthanum ratios of LDC and LSM in the composite were identified using XRD peak shift of LDC and magnetic properties of LSM, respectively. Electrical conductivity and oxygen diffusion coefficient were estimated with these dense composites. Oxygen diffusion coefficient were obtained by electrical conductivity relaxation method.

Non-stoichiometric composition of LSM increased oxygen diffusion coefficient as compared to stoichiometric LSM. LSM showed low oxygen diffusion coefficient, but nanocomposite with LDC much improved the coefficient even though LDC composite ratio is 10%. The coefficient of composite between non-stoichiometric LSM and LDC was similar to that containing stoichiometric LSM. Electrical conductivity of the composite showed significant difference between non-stoichiometric and stoichiometric LSM composition of the LSM/LDC composite. Inter-diffusion of lanthanum between LSM and LDC would much affected the conductivity. The LSM/LDC composite with stoichiometric LSM showed much lower conductivity than LSM since lanthanum was easily diffused into LDC, and LSM composition of the composite was much deviated from that of adequate LSM. However, the conductivity non-stoichiometric LSM derived composite was hardly reduced as compared to non-stoichiometric LSM. Non-stochiometric LSM would restrain inter-diffusion of lanthanum from LSM into LDC. Therefore, Non-stoichiometric LSM would have an advantage for using LSM/LDC nanocomposite as SOFC cathode.

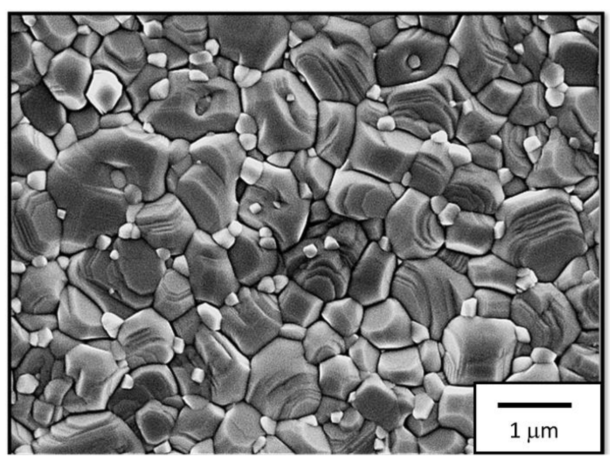

Figure 1. SEM image of LSM/LDC nanocomposite cathode obtained by sintering precursor powder synthesized by glycine method at 1200^oC for 5 h in air.