Surface Modification of NiO cathode for Molten Carbonate Fuel Cells (MCFCs)

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Introduction

The nickel oxide (NiO) is widely used as a cathode material for the molten carbonate fuel cells (MCFCs) due to its stability and high electrical conductivity in molten carbonate media. However, the nickel oxide is dissolved into molten carbonate by acidic dissolution mechanism under normal MCFC operation condition (oxygen atmosphere). Especially, the dissolution of Ni leads to the formation of Ni^{2+} which diffuses toward the anode, and it is precipitated in the matrix where it encounters dissolved H_2 from the anode. This precipitate of nickel causes internal short-circuits of the fuel cell. Recently, surface modification of NiO by stable materials has been studied. This modification protects the cathode material and hence suppresses the corrosion rates. Coating is one of the most effective ways to maintain the bulk properties and enhance the surface properties [1-3].

In this study, various La-coated Ni powders have been synthesized as a new cathode material to suppress the dissolution of cathode material and to maintain the advantages of the NiO cathode. [4-5]

Experimental

The La-coated Ni powders were prepared using Pechini method with a polymetric precursor. The La-coated Ni cathode is made by usual tape casting method and the green sheet was dried slowly at room temperature for 24 hours. After drying, the green sheet was sintered at 800 - 950 ^oC in H_2 atmosphere. Thermal gravimetric analysis (TGA) was performed to investigate the thermal behavior of the gel precursors. X-ray diffraction (XRD) and scanning electron microscopy/energy dispersive spectroscopy (SEM/EDS) were employed in characterization of NiO cathode. The solubility of the La-coated NiO cathode was measured in $(Li_{0.62}K_{0.38})_2CO_3$ molten carbonates. The solidified carbonates were dissolved in 1N nitric acid to investigate the dissolution of the cathode in the molten carbonate medium and the concentration of Ni dissolved in the carbonate melt is measured by inductive coupled plasma-atomic emission spectroscopy (ICP-AES).

Results and Discussion

Figure 1 shows morphological images and elemental distribution images of the pure Ni powder and La-coated Ni powders measured by SEM/EDS. From these SEM images, the surface of the Ni powder is covered with small particles. This small particle of La was distributed evenly over Ni particles. The La particles do not cause a significant change in the morphology of Ni particle and they were well dispersed on the surface of the Ni particle. **Figure 2** shows the SEM images of the pure Ni cathode and La-coated Ni cathode after sintering under reduction atmosphere. The morphology of the La-coated Ni cathode after sintering was similar to pure Ni cathode and it is shown to have good pore structure.

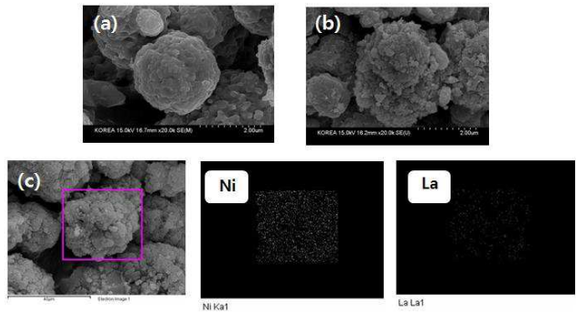

Figure 1. SEM images of pure Ni powder; (a) La-coated Ni powder; (b) mapping of Ni and La ; (c)

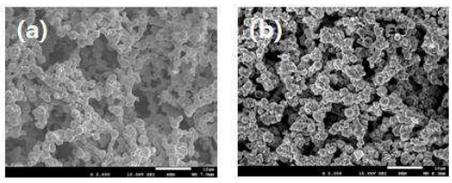

Figure 2. SEM images of the pure Ni cathode; (a) and La-coated Ni cathode; (b) after sintering in the reduction atmosphere

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References

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