

CHAPTER IV

CONCLUSION

4.1 Conclusion

The K_2NiF_4 type oxide including $(La_{0.8}Sr_{0.2})_{2-x}Ca_xNiO_4$ (LSN- Ca_x , $x=0-0.5$), $(La_{0.8}Sr_{0.2})_{2-x}Ca_xNi_{0.9}Co_{0.1}O_4$ (LSNC- Ca_x , $x=0-0.5$) and $La_{2-x}Ca_xNi_{0.9-y}Co_{0.1}(Fe,Zn)_yO_4$ (LNCF- Ca_x and LNCZ- Ca_x , $y=0-0.2$, $x=0-0.7$) were prepared by modified citrate method with the calcination temperature of 900°C and sintering temperature of 1350°C for 10 hours. The compounds were characterized for phase structure, surface morphology, conducting property, oxygen permeation and electrochemical property.

All LSN- Ca_x and LSNC- Ca_x exhibited K_2NiF_4 -type with tetragonal structure. The pure single phase was obtained only for $x=0-0.2$ while at $x>0.2$ the formation of CaO impurity phase was observed. SEM images of sintered discs revealed that Ca^{2+} substitution promoted the higher grain size and the larger density of materials. Additionally, it resulted in an increase in electrical conductivity. The highest electrical conductivity values of 176.9 and 166.9 S/cm at 800°C were achieved for LSN- $Ca_{0.2}$ and LSNC- $Ca_{0.2}$, respectively.

The incorporation of Fe and Zn at Ni-site of $La_2Ni_{0.9-y}Co_{0.1}(Fe,Zn)_yO_4$ (denoted as LNC- Fe_y and LNC- Zn_y) produced the single phase of K_2NiF_4 -type structure when $y\leq 0.05$. At $y>0.05$, La_2O_3 impurity phase was detected. The SEM analysis indicated that Fe and Zn substitution did not affect the grain size and the density of materials. However, it affected the oxygen permeation rate. The oxygen permeation rate increased with increasing Fe and Zn content. LNC- $Fe_{0.05}$ and LNC- $Zn_{0.05}$ showed the highest oxygen permeation rate of 0.57 and 0.41 $\mu\text{mol/s.cm}^2$ at 1000°C , respectively.

When substitution of Ca^{2+} ion at La-site of LNC- $Fe_{0.05}$ and LNC- $Zn_{0.05}$, the single phase of K_2NiF_4 type structure was obtained at $x=0-0.5$ whereas at $x>0.5$, CaO impurity phase was appeared. The substitution of Ca^{2+} enhanced the material density confirmed by SEM images and increased the electrical conductivity of materials. The highest electrical conductivities were achieved for LNCF- $Ca_{0.5}$ and LNCZ- $Ca_{0.5}$ and the values were 98.4 and 84.9 S/cm, respectively at 800°C .

Electrochemical performance was determined for LNCF- $Ca_{0.5}$ /LSGM/Ni-Fe and LNCZ- $Ca_{0.5}$ /LSGM/Ni-Fe and the maximum power densities at 800°C were 322 and 312, respectively.



Based on the results, it can be concluded that substitution of Ca^{2+} ion at A-site and substitution of Fe and Zn at B-site can improve the electrical conductivity and the oxygen permeation of materials in this study. LNCf- $\text{Ca}_{0.5}$ and LNCZ- $\text{Ca}_{0.5}$ are interesting materials for using as cathode in IT SOFC because of its high single cell performance with LSGM electrolyte.

4.2 Suggestions

- 1) To study the single cell performance of LSN- $\text{Ca}_{0.2}$ and LSNC- $\text{Ca}_{0.2}$ using another electrolyte, with gadolinium- or samarium-doped ceria being an example.
- 2) To study the long-term stability test of the single cell.
- 3) To investigate other properties such as structural property and thermal expansion coefficient (TEC) in order to obtain more details of materials.

