고체산화물 연료전지 연료극 적용을 위한 다공성 GDC 전극과 촉매 함침에 대한 연구

Study on porous GDC scaffold electrode and catalyst infiltration for solid oxide fuel cell anode

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Abstract

Solid oxide fuel cell(SOFC) anode is commonly fabricated with uniformly mixed oxidizer and catalyst, however, catalyst infiltration on fabricated porous scaffold electrode enables to use various catalysts which have relatively low melting temperatures and to achieve cell performance with relatively low catalyst amount. In this study, Ni, which is widely used catalyst for SOFC anode, was infiltrated into porous GDC(Gadolinium-doped ceria) scaffold electrode, which has higher ionic conductivity than YSZ(Yttria-stabilized zirconia), to analyze performance and polarization characteristics of SOFC anode as the amount of infiltrated Ni increases. Half cell was fabricated by screen-printing porous GDC scaffold electrode on dense YSZ electrolyte pellet, and synthesized Ni nitrate solution was infiltrated into fabricated half cell electrode. SEM(Scanning electron microscope) image of electrode and EIS(Electrochemical impedance spectroscopy) of half cell were conducted to analyze polarization characteristic. Ohmic resistance decreased as the amount of infiltrated Ni increases, however, mechanical fracture of electrode occurred after certain amount of Ni infiltrated.

Introduction

▪ Solid Oxide Fuel Cell (SOFC)

- High energy conversion efficiency ➔ Good alternative for green energy
- Issues for SOFC anode
  ➔ Limitations of Ni-based anode
  ➔ Weak at carbon deposition and redox cycle

▪ Catalyst infiltration

- Catalyst infiltration into fabricated porous scaffold electrode
- Intense percolation at triple phase boundary(TPB)
  ➔ Increase of stability and performance of cell
- Low sintering temperature
  ➔ Availability of various catalysts with low melting temperatures

< Process of catalyst infiltration >

Experimental

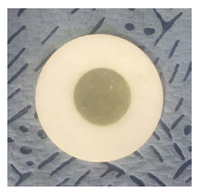
▪ YSZ electrolyte of half cell

- Dense electrolyte pellet: Low cost, simple process
- YSZ(TZ-8Y, TOSOH, Japan)
- Diameter of 2.5cm

< YSZ pellet >

▪ GDC scaffold electrode of half cell

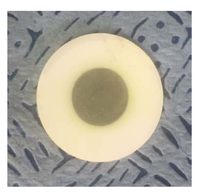
- Screen printing method
- GDC(LSA, Rhodia, USA)
- Porosity control by sintering temperature



< 4.24wt% of Ni >

▪ Ni infiltration into GDC scaffold

- Synthesis of Ni nitrate solution
- Iterative method till desired amount of catalyst
- Dried & sintered
- wt% = $\frac{weight\ of\ infiltrated\ Ni}{weight\ of\ GDC\ scaffold} * 100(\%)$



< 9.08wt% of Ni >

▪ Impedance spectra analysis

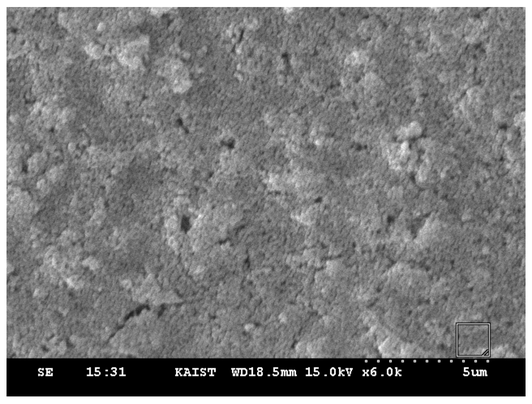
- The AC impedance spectra of fabricated half cells (SI 1260, SI1287, Solartron, UK)
- Tested by 4-probe method

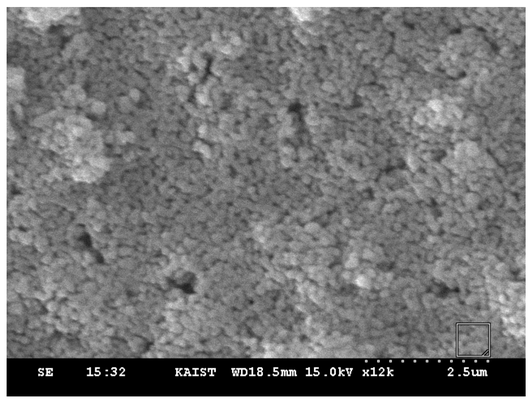
< 16.9wt% of Ni >

Result

▪ SEM images of nano-porous GDC scaffold electrode

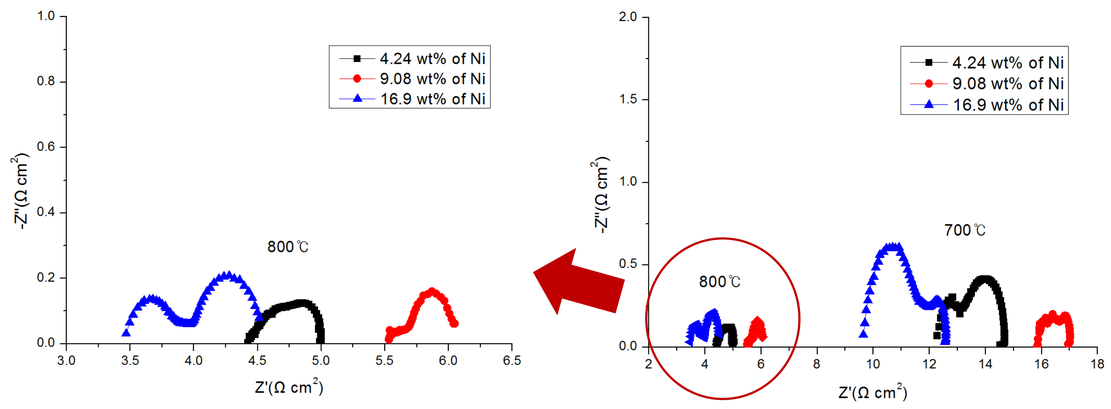
- SEM images before catalyst infiltration
- Low porosity of GDC scaffold due to its relatively low sintering temp.





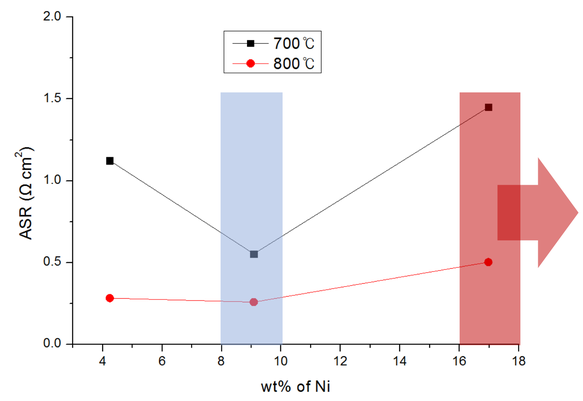
▪ Impedance spectra of Ni infiltrated GDC half cell

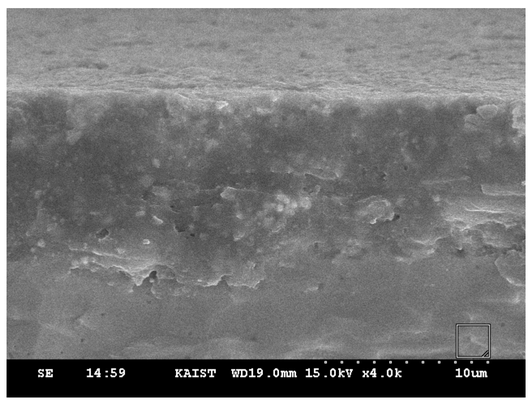
- Lowest area specific resistance(ASR) with intermediate amount of Ni
- Lowest Ohmic resistance with high amount of Ni



▪ ASR analysis of Ni infiltrated GDC half cell

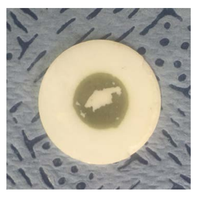
- At low amount of Ni → deficiency of percolation
- At high amount of Ni → blocked pores of scaffold





Conclusion

- Fabrication of Ni infiltrated GDC scaffold electrode half cell
- Nano-porous GDC scaffold due to its low sintering temp.
- Lowest ASR with intermediate amount of Ni infiltrated half cell
- Mechanical fracture with over 20wt% of Ni infiltrated



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