INFLUENCE OF CALCINATION ON THE PROPERTIES OF La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_{3-δ}
SAMARIA DOPED CERIA CARBONATE COMPOSITE CATHODES FOR LT-SOFC

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INTRODUCTION

- Combination of cathode and electrolyte in the composite cathode has constructed a dual-phase composite that allows both electrons (e-) and O2- to be transferred simultaneously through the cathode, thus increase the ionic conductivity of the cathode and enhance the cell performance [1].
- The cathode electrochemical performance is basically depending on its initial powder properties such as initial particle size, agglomeration and specific surface area. The stated powder properties are closely related to the degree of calcination [2,3].
- The effects of the calcination temperature on the chemical compatibility, particle sizes and the electrochemical performance of the composite cathodes were investigated.

METHODOLOGY

- Commercial cathode powder La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_{3-δ} (LSCF)
- In-house developed electrolyte powder samarium-doped ceria carbonate (SDCC)
- Composite cathode LSCF-SDCCS5 (50 wt% LSCF : 50 wt% SDCC) - ball milling
- Characterisation
  - TEM micrograph of the uncalled LSCF-SDCC powder
  - XRD, FTIR
  - Electrochemical analysis - EIS
- Fig 1. Flow chart of the preparation and characterisations of the composite cathode LSCF-SDCCS5

RESULTS & DISCUSSION

- The XRD patterns demonstrated that no secondary compound - confirmed that no chemical reactions occurred between the cathode and electrolyte powder at all the calcination temperatures.
- The FTIR spectra (Fig. 3) - provided evidence to the presence of CO2 in the LSCF-SDCCS5 composite cathode at all the calcination temperatures. The CO2 group is indicated by the absorption bands at 858 cm⁻¹ and 1436 cm⁻¹.
- Table 1. Ionic conductivity of the LSCF-SDCCS5 composite cathode at 550°C operating temperature
  - Calculation temp. (°C) | Conductivity, σ (x 10⁻² Scm⁻¹)
  - 700 | 0.67
  - 750 | 0.95
  - 800 | 0.63
  - 850 | 0.11
- Fig 3. FTIR spectra of the (a) uncalled LSCF-SDCCS5 composite cathode powders and calcined at (b) 700 °C, (c) 750 °C, (d) 800 °C and (e) 850 °C
- Fig 4. FESEM image of the LSCF-SDCCS5 composite cathode powder calcined at (a) 700 °C and (b) 850 °C (50 kx magnification)
- The increment of particle size of the composite powders was observed upon the increment of the calcination temperature (Fig. 4).
- The obtained surface areas were comparable with the previous research on other composite cathodes [4].
- Generally, the impedance analysis demonstrated that the low frequency arc was more dominant under all operating temperature - indicates that the rate limiting mechanism is diffusion related.
- Conductivity of the LSCF-SDCCS5 cathode calcined at 750 °C - comparable with the results of previous researchers, suggesting that this can be used as an electrode for low temperature solid oxide fuel cell (LT-SOFC) [1].
- Fig 5. AC impedance spectra of the half-cell samples of LSCF-SDCCS5 in air. The composite cathode powders were calcined at 700 °C
- Fig 6. ASR of the LSCF-SDCCS5 composite cathode with respect to calcination temperatures

REFERENCES

[1] Fan, B., Yan, J. and Yan, X. (2011). The Ionic Conductivity, Thermal Expansion Behavior, and Chemical Compatibility of La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_{3-δ} as SOFC Cathode Material, Solid State Sci. 13 (10) 1835.

CONCLUSION

- Electrochemical analysis demonstrated that 750 °C is the optimum calcination temperature for the LSCF-SDCCS5 composite cathode – gave the lowest ASR and the highest ionic conductivity, 0.95 x 10⁻² Scm⁻¹.
- The LSCF-SDCCS5 can be considered as a potential cathode for LT-SOFC. The findings also signify the initial powders properties have very important influences on electrode performance.