Influence of Binary Carbonate on the Properties of Low Temperature Cathode Composite SOFC

Linda Agun[1],Hamimah Abd. Rahman*[1],Sufizar Ahmad[1]and Andanastuti Muchtar[2]
[1]Faculty of Mechanical and Manufacturing Engineering, UniversitiTun Hussein Onn Malaysia, 86400 Parit Raja, BatuPahat, Johor, Malaysia
[2]Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia

*Email: hamimah@uthm.edu.my

Abstract
Cathode-carbonate is prospective materials for low temperature solid oxide fuel cells (LT-SOFCs). The influence of carbonate on the properties of cathode LT-SOFCs is studied. Difference amount of binary carbonate (Li_2CO_3:Na_2CO_3) is prepared at molar ratio of 67:33 and 62:38.The cathode composite powders were calcined at 750°C for 2 hours before uniaxial press. XRD results confirmed that carbonate in cathode composite exist as amorphous phase when no additional peaks was observed in the XRD pattern. This exhibits carbonate has a good compatibility with cathodes composite powders. The developed cathode composite also gave the acceptable porosity values between 25 to 27%. The finding shows that the amount of binary carbonate in cathode composite has some influences on its properties.

Introductions
High demand of electricity and increase of pollutions has brought to the development of SOFCs. Recently, LT-SOFC operating in range 400 to 600°C had attracted more attention in these two decades [1,2].$La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}$ (LSCF6428) perovskite and samarium doped cerium carbonate (SDCC) shows excellent compatibility and outstanding properties for SOFCs composite cathode materials such as improved stability, enhancement of the ionic conductivityand suppresses the electronic conduction of doped ceriaat low temperatures [3].
The quality of SDCC electrolyte composite truly depends on composition, materials selection, preparations technique, calcination and sintering temperature, and particle size. These criteria will influence the physical and chemical properties, and cell performance respectively [4]. In the present study, the influence of difference molarities of binary carbonate on the properties of LT-SOFC composite cathode was examined.

Experimental Method
20 wt.%(Na/Li) carbonate with varies binary carbonate of molar ratio (67:33 and 62:38) were mixed together with 80 wt.% SDC via wet-ball milling in alcohol medium. The wet electrolyte mixture then dried-oven for overnight before calcination process at 680°C for 1 hour.

Cathode composite powders consist of 50 wt.% SDCC electrolyte with 50 wt.% commercial LSCF6428. The cathode composite mixtures were ball milled in alcohol medium at 550 rpm for 2 hours. After dried for overnight, the cathode composites powders were calcined at 750 °C for 2 hours. The composition of composite cathode powders is shown in Table 1.

Table1: Composition of composite cathode with varies molar ratio of carbonate.

Samples	Li_2CO_3 (mol.%)	Na_2CO_3 (mol.%)
LSCF-SDC-73LN	67	33
LSCF-SDC-28LN	62	38

Pellet in 13 mm diameter with ~0.70 mm thickness is prepared via uniaxial press. The pellets were sintered for 90 minutes at temperature 600°C before when through porosity analysis.

Results &Discussion
Fig. 1 shows XRD patterns of electrolyte composite powders at differences carbonate molar ratio. There are no secondary peak for

SDC electrolyte and LSCF6428, which means the carbonates exist as amorphous state after through calcinations process. However, for the other LSCF-SDCC composite powders, there are some unidentified peak at range of 2θat 25°, 26°, 37° and 44°appear after mixing process and need further investigations.

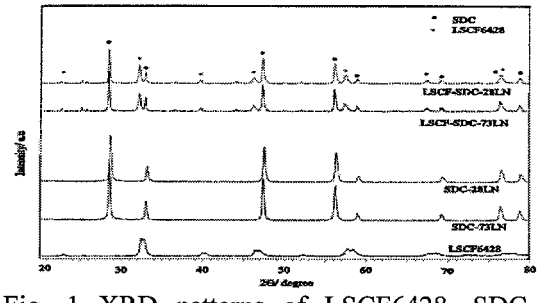

Fig. 1 XRD patterns of LSCF6428, SDC-73LN, SDC-28LN, LSCF-SDC73LN and LSCF-SDC28LN powders after calcination.

FTIR was conducted to examine the existence of carbonate in the calcined composite powders on difference molar ratio of binary carbonate. As shown at Fig. 2, a characteristic broad band in the range of 1442–705 cm^{-1} was related to the presence of carbonate (CO_3^{2-}) [5]. LSCF-SDCC composite powders shows peak at range 633, 670, 1506 and 1513cm^{-1} respectively suddenly disappear. One possible reason is the powders are fully coat by a thin layer of carbonate forming a core-shell during calcinations and mixing. Increasing of peak can be observed from LSCF-SDC-73LN to LSCF-SDC-28LN due to higher molarity of carbonate.

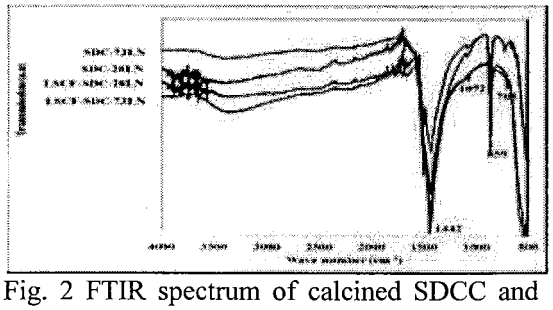

Fig. 2 FTIR spectrum of calcined SDCC and LSCF-SDCC composite powders.

Data in Table 2 shows both of the binary carbonate molar ratios are suitable for LT-SOFCs porosity range (20%-40%). Existence of carbonate and sintering process has an influence to the densification of the LT-SOFCs.

Table 2 Porosity results for sintered cathode composite pellet.

Sample	Porosity [%]
LSCF-SDC-73LN	27.36
LSCF-SDC-28LN	25.38

Conclusion

Both of the carbonate molarity is suitable for the cathode composite compositions. The XRD results show good compatibility of the carbonates in LSCF-SDCC cathode composite. The porosity values also signify that binary (Li/Na) carbonate is suitable for LSCF cathode composite materials. Further study need to be conducted on electrochemical aspects for LSCF-SDCC for LT-SOFCs in order to choose and confirm the appropriate carbonate content.

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