Intermediate temperature fuel cell based on a co-doped ceria-carbonate electrolyte

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Ceria-carbonate composite materials have been widely investigated as promising candidates of electrolytes for intermediate-temperature fuel cells (IT-FCs). Also, co-doping of ceria with two or more hetrovalent ions enhances the ionic conductivity more as compared to singly doped ceria. Considering the low cost and high stability of doped ceria, $Ce_{0.8}Sm_{0.15}Sr_{0.05}O_{1.9}$ (SSDC)–carbonates material was prepared and characterized in this work. An anode-supported fuel cell with SSDC-20wt.% carbonates composite electrolyte was fabricated and characterized.

SSDC was prepared by sodium carbonate co-precipitation method. Then SSDC was mixed with 20 wt% $LiNaCO_3$(Li_2CO_3:Na_2CO_3=1:1). A range of techniques including XRD, SEM, TG and A.C. impedance were applied to characterize the microstructure, morphology, phase transition behavior and conductivity of SSDC power and the composite electrolyte.

In addition, an anode-supported fuel cell with SSDC-20wt.% carbonates composite electrolyte was fabricated via a tri-layer co-pressing and co-sintering technique, using NiO/electrolyte as composite anode and lithiated NiO/electrolyte as composite cathode.

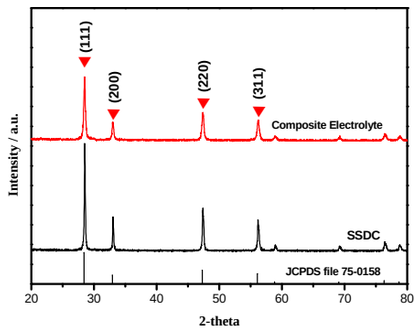

Fig. 1. XRD patterns of (a) SSDC-20 wt.%$LiNaCO_3$ composite, (b) SSDC, (c) JCPDS file 76-0158

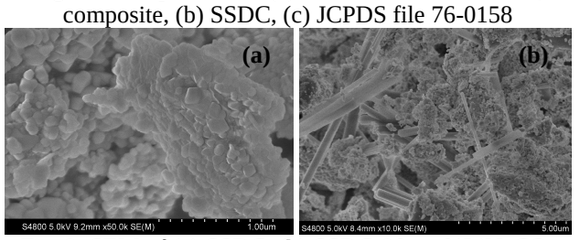

Fig. 2. SEM of (a) SSDC, (b) SSDC-20 wt.%$LiNaCO_3$ composite

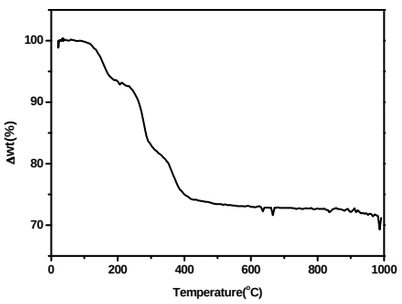

Fig. 3. TG curve of SSDC precursor

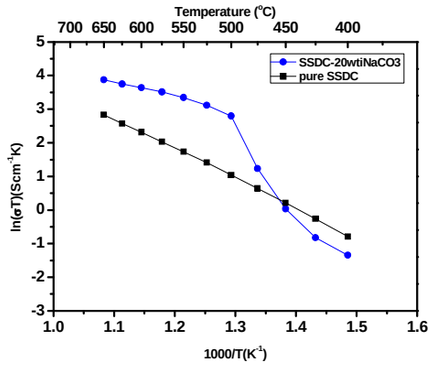

Fig. 4. The conductivity measured by a.c. impedance technique of pure SSDC and SSDC-20 wt.%$LiNaCO_3$ composite electrolyte

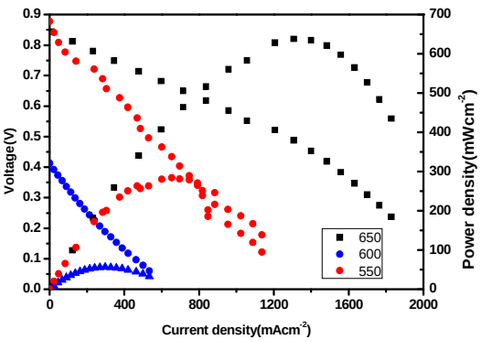

Fig. 5. Performances of H_2/O_2–CO_2 single cell with SSDC-20 wt.%$LiNaCO_3$ composite electrolyte

The results indicated that SSDC-carbonate can form a uniform composite and a continuous phase interface. A transition of conductivity with temperature and conductivity enhancement effect occurred among the composite electrolyte samples. At 650 ^oC, the conductivity of electrolyte was 0.06 S/cm, higher than 0.018 S/cm of SSDC powder, which indicates composite materials are more promising than pure SSDC in the development of IT-SOFCs. Using hydrogen at the anode side, oxygen and carbon dioxide at the cathode side, the cell achieved peak power density of 669 $mWcm^{-2}$ and an open circuit voltage (OCV) of 0.93 V at 650 ^oC.

An anode-supported fuel cell with SSDC-20 wt.% carbonates composite electrolyte has been prepared successfully. Peak power density up to 669$mWcm^{-2}$ and an open circuit voltage (OCV) of 0.93 V was achieved at 650 ^oC. The stability of single cell should be further studied.

References

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