A Novel Perovskite structure anode of SOFC for Production of Electricity and Separation of CO from Syngas

Yi-Fei Sun, Guang-Ya Wang, Jing-Li Luo & Karl T. Chuang

Department of Chemical and Materials Engineering, University of Alberta
Edmonton, Alberta T6G 2G6, Canada

Introduction

Syngas (H_2+CO) has wide applications. It is an important raw material for organic synthesis and can be used as fuel. Recently, the solid oxide fuel cell (SOFC) has attracted much attention because of its fuel flexibility, high efficiency of using fuel and environmental friendly characteristics [2]. Previous studies [3]showed that the electronic and ionic conductivity of a Fe-based perovskite structure composite could be enhanced by substituting A-site of La by Sr. And the B site of Fe could be partially substituted by Cr to sustain high disorder of oxygen vacancy.

We proposed to use proton conducting solid oxide fuel cell (PCSOFC) for generating electricity and enriching CO from syngas. In the PCSOFC, oxygen in the cathode cannot transport to anode to oxidize CO. Therefore, in the anode chamber, H_2 is oxidized and the protons transport to cathode through the proton conducting electrolyte to react with oxygen to form water in cathode chamber. In this work, we fabricated $La_{0.3}Sr_{0.7}Fe_{0.7}Cr_{0.3}O_{3-\xi}$ (LSFC), a perovskite structure composite, as the anode catalyst for SOFCs. The chemical stabilities in different gas atmospheres at operating temperature were investigated.

Experimental

The LSFC composite powders were prepared by a modified-combustion method [4]. Stoichiometric amounts of metal nitrates were first dissolved in water. Subsequently, glycine was added with the molar ratio of glycine: total metal as 2: 1. The solution was then stirred and heated on a hot plate until ignited to form fine nano-powder. The powders were calcined at 1200 ^oC for 2 h in air by the rate of 2 ^oC/ min.

To study high temperature phase and chemical stabilities, the XRD patterns for LSFC before and after the treatment in (a) 10%H_2 + N_2 and (b) in humidified CO_2 (3% H_2O) at 700 ^oC for 8 h were obtained by Rigaku RU200 powder X-ray diffraction (XRD), with a scan rate of 2^o min^{-1}.

Results and discussions

It is widely known that high temperature thermal stability is quite important for electrode material in SOFC. Also, the stability of LSFC in CO_2 and H_2O in cathode is important as well if a symmetrical SOFC is used to study the catalytic activity of LSFC. The mechanism of deactivation was studied after long-time operation.

Figure 1 shows that LSFC composite exhibited a pure perovskite structure at room temperature. After the treatment in 10%H_2+N_2 at 700 ^oC for 8 h, the structures of the materials had no obvious change with all of the peaks being assigned to perovskite phase, which implied that the LSFC material had good high temperature phase stability.

Figure 1 also shows the XRD pattern for LSFC after the treatment in humidified CO_2 (3% H_2O) at 700 ^oC for 8 h. It is clear that the LSFC retained its perovskite structure after the treatment. The results indicate that the LSFC had excellent chemical stability in CO_2 and H_2O at the operating temperature and therefore could be a promising electrode material for SOFC fueled by syngas.

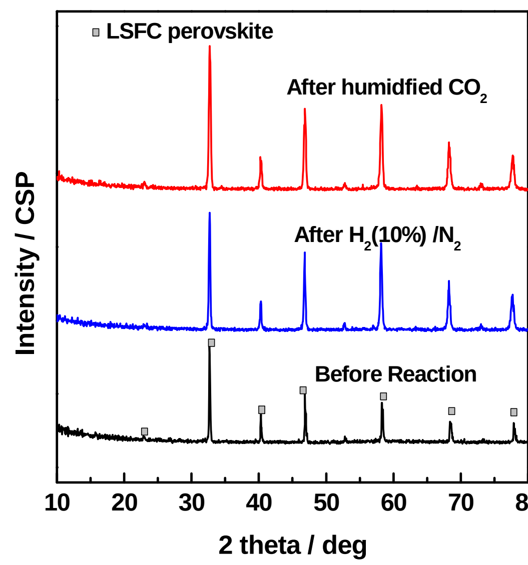

Figure 1. XRD patterns of LSFC before and after the treatment in different atmospheres at 700 ^oC for 8 h.

Conclusion

The LSFC exhibits high chemical stability in H_2 and good tolerance to CO_2 and H_2O, which is an important characteristic for promising electrode material for syngas SOFC.

References

[1] Waki, Norihisa, Jpn. Kokai Tokkyo Koho (2004), JP 2004217438 A 20040805.
[2] M. Gong, X. Liu, J. Trembly, C. Johnson, Journal of Power Sources 168 (2007) 289.
[3] H. Ullmann*, N. Trofimenko, F. Tietz, D. Sto¨ver, A. Ahmad-Khanloub， Solid State Ionics 138 (2000) 79–90
[4] Min Chen, Scott Paulson, Venkataraman Thangadurai, Viola Birss, Journal of Power Sources 236 (2013) 68-79.