DEVELOPMENT OF LSM/YSZ COMPOSITE ELECTRODES FOR THIN FILM SOFCs

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Recently anode-supported solid oxide fuel cell (SOFC) with thin film yttria-stabilized zirconia (YSZ) electrolyte (5-20μm) has attracted great interests due to its ability to achieve good performance at intermediate operating temperature (600-800°C) (1). Cathode polarization performance is often the main limiting factor for the SOFC operating at intermediate temperatures (2). $La_{1-x}Sr_xMnO_3$ perovskite (LSM) is regarded as one of the most promising cathode for use in high temperature SOFC because of its high thermal and chemical stability, relatively good compatibility with YSZ (3, 4). However, it is well known that LSM is limited in the application of cathodes in intermediate temperature SOFC. One common used means for improving LSM cathode performance is to add ionically conducting second phase such as YSZ to LSM cathode to form a composite cathode, resulting in the significant decrease of interfacial resistance of single phase LSM cathode. Much work is focused on the development of LSM/YSZ composite cathode. It has been found that the performance of LSM/YSZ composite cathodes is strongly dependent on the characteristic of cathode materials, cathode processing, cathode composition and measurement (5-8). In this paper, The effects of cathodic current passage, $(La,Sr)MnO_3$(LSM) stoichiometry and surface treatment of YSZ electrolyte on the performance of LSM/YSZ composite cathode were investigated. The results showed that LSM/YSZ cathode performance can be significantly improved by using A-site deficient LSM and through surface treatment of YSZ electrolyte.

Fig. 1 shows the impedance of $La_{0.85}Sr_{0.15}MnO_3$ (LSM-A)/YSZ, LSM-A/$MnCO_3$/YSZ and $(La_{0.85}Sr_{0.15})_{0.9}MnO_3$ (LSM-B)/YSZ composite cathodes at 800 °C in air and under open circuit. The electrodes were stabilized after cathodic current passage at 200mA cm^{-2} for 4h. The interfacial resistance (R_E) of LSM-B/YSZ cathode was only 0.5 ohm cm^2, three times smaller than that of LSM-A/$MnCO_3$/YSZ cathode (1.7 ohm cm^2) and eight times smaller than that of LSM-A/YSZ cathode (3.94 ohm cm^2). This indicated that the electrochemical activity of LSM-B/YSZ cathode towards to oxygen reduction was much higher than that of LSM-A/YSZ cathode, which was indicated by the corresponding polarization performance The low interfacial resistance and good cathode performance of LSM-B/YSZ composite cathode is believed to be due to the suppressing of the formation of resistive lanthanum zirconate phase.

Fig. 2 shows the impedance and polarization curve at 800°C in air of a LSM-B/YSZ composite cathode on YSZ electrolyte with and without polishing by sand paper. The electrode interfacial resistance of LSM-B/YSZ electrode on polished YSZ surface was very low, 0.27 ohm cm^2 while on as-sintered YSZ surface it was 0.5 ohm cm^2. Polishing may remove the impurities such as silica from the YSZ electrolyte surface, promoting the oxygen ions transfer process and thus reducing the electrode interfacial resistance of the composite cathode.

The anode-supported SOFC with 15μm thick YSZ electrolyte, Ni/YSZ cermet anode and LSM-B/YSZ composite cathode was tested at 800°C and achieved high performance: OCV 1.06V, ohmic resistance 0.12 ohm cm^2, and the power density 0.98 Wcm^{-2}. The high power output of the anode-supported thin electrolyte cell shows the good performance of the LSM-B/YSZ composite cathodes.

The effect of cathodic current passage on the performance of LSM/YSZ composite cathode was also investigated.

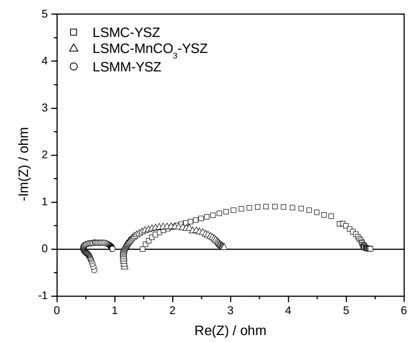

Fig. 1 Impedance measured at 800°C in air and under open circuit of LSM-A/YSZ, LSM-A/$MnCO_3$/YSZ and LSM-B/YSZ composite cathodes.

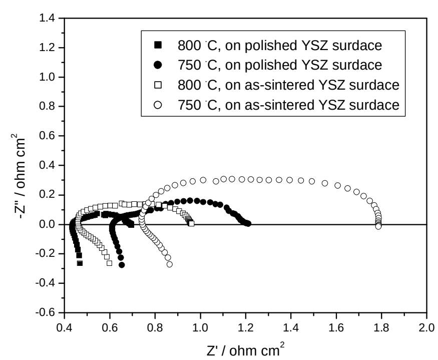

Fig. 2 Comparison of impedance at OCV in air between a LSM-B/YSZ composite cathode on polished YSZ electrolyte and that on as-sintered YSZ electrolyte surface.

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