Evaluation of infiltrated Bi2V0.9Cu0.1O5.35, Ce0.9Gd0.1O1.95 and Bi2V0.9Cu0.1O5.35-based composite cathodes for solid oxide fuel cells

Samson, Alfred Junio; Søgaard, Martin; Bonanos, Nikolaos

Published in:
Abstract book

Publication date:
2011

Document Version
Peer reviewed version

EVALUATION OF INFILTRATED $Bi_2V_{0.9}Cu_{0.1}O_{5.35}$, $Ce_{0.9}Gd_{0.1}O_{1.95}$ AND $Bi_2V_{0.9}Cu_{0.1}O_{5.35}$ – BASED COMPOSITE CATHODES FOR SOLID OXIDE FUEL CELLS

Alfred Samson,[1*] Martin Søgaard,[1] and Nikolaos Bonanos[1]
[1] Fuel Cells and Solid State Chemistry Division, Risø National Laboratory for Sustainable Energy, Technical University of Denmark, Frederiksborgvej 399, DK-4000, Roskilde, Denmark

*asam@risoe.dtu.dk

Keywords: $Bi_2V_{0.9}Cu_{0.1}O_{5.35}$, infiltration, cathode, SOFC

Introduction

The compound $Bi_2V_{0.9}Cu_{0.1}O_{5.35}$ (BICUVOX) exhibits very high oxide ion conductivities – about two orders of magnitude higher than that of other oxide ion conductors at low temperatures (<500°C) [1]. In a solid oxide fuel cell cathode where high ionic conductivity, high catalytic activity and high electronic conductivity are essential, it is possible to use BICUVOX as an ion conducting component in a composite. However, the choice of BICUVOX in this way is restricted by its micro-structural instability and reaction with other cell components during processing and during operation at high temperatures. A way to mitigate the problem of reactivity of BICUVOX with other materials is to separate the processing of BICUVOX with that of the desired electro-catalyst. This can be accomplished through an infiltration method. In this technique, a liquid solution usually composed of dissolved metal nitrates is introduced into a backbone followed by firing. The present study investigates the electrochemical performance of cathodes prepared using a BICUVOX backbone that is infiltrated with $La_{0.6}Sr_{0.4}CoO_{3-\delta}$ (LSC40). The performance of the cathodes is investigated as a function of firing temperature of the BICUVOX backbone and the number of infiltrations. The obtained results are compared to high performance electrodes prepared by infiltrating LSC40 into a $Ce_{0.9}Gd_{0.1}O_{1.95}$ (CGO10) backbone [2]. Theoretically, the replacement of CGO10 with a much higher ionic conductivity BICUVOX should result in a much higher performance cathode.

Experimental

The starting BICUVOX material was prepared by conventional solid-state synthesis. The electrical conductivity of a dense BICUVOX sample was measured using an ac four-point impedance measurement technique. Porous backbones (BICUVOX and BICUVOX-CGO10, 50:50 vol%) for infiltration were prepared by screen printing onto a dense CGO10 electrolyte followed by firing. The backbones were infiltrated multiple times with LSC40 and PdCo(40%) followed by firing. The electrochemical performance and chemical compatibility among the materials were investigated.

Results and Discussion

The total conductivity of the BICUVOX at 500°C was measured to 0.057 S cm^{-1} which is approximately 10 times higher than CGO10 at this temperature. A firing temperature greater than 800°C was necessary to ensure adhesion to the dense CGO10 electrolyte. However, at this high temperature the BICUVOX looses porosity due to extensive sintering. From scanning electron microscopy and X-ray diffraction the formation of several phases was revealed. The polarization resistances (R_p) at 500°C, measured using electrochemical impedance spectroscopy on symmetrical cells in ambient air were 41 Ω cm^2 and 49 Ω cm^2 for BICUVOX backbones infiltrated 6 times with LSC40 and PdCo40 (all fired at 500°C), respectively. These values are approximately 100 times higher than the one obtained for the CGO10 backbone infiltrated with the same amount of LSC40[2]. The values of R_p as function of the reciprocal absolute temperature are shown in Fig. 1. The inferior cathode performance using BICUVOX backbones is attributed to a poor microstructure and the chemical reactivity with the dense CGO10 electrolyte and with the infiltrated material.

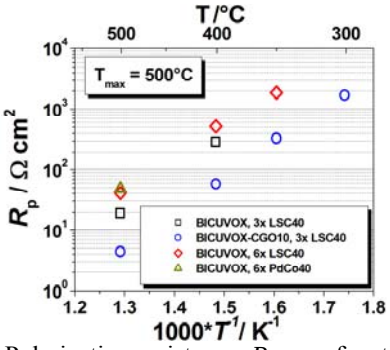

Fig. 1 Polarization resistance, R_p, as a function of the reciprocal absolute temperature for all the infiltrated cathodes. The infiltrated materials were fired at 500°C.

Conclusions

The study has investigated the use of BICUVOX as a backbone material for infiltration. The polarization resistance of the electrode prepared with the BICUVOX backbone was approximately a factor of 100 higher than that of a corresponding electrode prepared using a CGO10 backbone. The poor performance of the BICUVOX backbone is attributed to a coarse microstructure and chemical reaction between the BICUVOX and electrolyte/ electro-catalyst.

References

[1] J.C. Boivin et al., *Chem. Mater.*, 10 (1998) 2870.
[2] A. Samson et. al., submitted to *J. Electrochem Soc*.