Accepted Manuscript

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PII: S0925-8388(17)31992-8

DOI: 10.1016/j.jallcom.2017.06.018

Reference: JALCOM 42086

To appear in: *Journal of Alloys and Compounds*

Received Date: 19 April 2017

Revised Date: 1 June 2017

Accepted Date: 2 June 2017

Please cite this article as: H. Fan, Y. Zhang, M. Han, Infiltration of $La_{0.6}Sr_{0.4}FeO_{3-\delta}$ nanoparticles into YSZ scaffold for solid oxide fuel cell and solid oxide electrolysis cell, *Journal of Alloys and Compounds* (2017), doi: 10.1016/j.jallcom.2017.06.018.

Infiltration of $La_{0.6}Sr_{0.4}FeO_{3-\delta}$ nanoparticles into YSZ scaffold for solid oxide fuel cell and solid oxide electrolysis cell

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Abstract:

$La_{0.6}Sr_{0.4}FeO_{3-\delta}$ (LSF) nanoparticles were infiltrated into porous YSZ scaffold to fabricate composite LSF-YSZ oxygen electrode for both solid oxide fuel cell (SOFC) and solid oxide electrolysis cell (SOEC). X-ray diffraction (XRD) pattern and scanning electron microscopy (SEM) images have demonstrated that the formation of LSF perovskite phase and uniform distribution of nano-structural LSF particles onto inner surface of the YSZ scaffold, respectively. Polarization curves and electrochemical impedance spectra (EIS) were employed for the characterization of electrochemical properties of the cell for both power generation and high-temperature steam electrolysis. Furthermore, the long-term durability of the LSF-infiltrated cell was galvanostatically carried out under both SOFC and SOEC operations. For SOFC operation, the cell experienced a significant degradation in the initial 50 h and subsequently was sustained at a stable operation, with overall ohmic and polarization resistance variation from 0.20 to 0.25 Ω cm^2 and from 0.55 to 0.60 Ω cm^2, respectively. For SOEC operation, the cell showed high long-term durability operation, with almost unchangeable ohmic resistance and slightly varied polarization resistance from 0.41 to 0.43 Ω cm^2.

Keywords:

Solid oxide fuel cell; Lanthanum strontium ferrite; Infiltration; Solid oxide electrolysis cell; Nano-structural electrode

1. Introduction

To solve energy crisis and environmental pollution problems resulted from utilization of fossil fuels, it has attracted increased attention to development of clean energy technology. Solid oxide fuel cell (SOFC) is considered to be one of the most environmental-friendly and efficient power generation technologies, with which electric energy is directly converted into chemical energy without Carnot cycle. By introducing fuels such as hydrogen gas, methane, carbon monoxide, etc., electricity was generated with only emission of water and carbon dioxide [1]. SOFCs are generally operated at high temperatures of 600-1000 ^oC to promote rapid kinetics and low resistance. Solid oxide electrolysis cell, which is inverse to SOFC, is capable of generating hydrogen (syngas) and oxygen from steam (H_2O and CO_2) by applying an external electric current [2]. High temperature