Improving performance of nanostructured (La,Sr)(Cr,Mn)O_3/YSZ cathode for high temperature steam electrolysis

Mehrshad Kamali Khameneh[1], Alireza Babaei[2], Abolghasem Ataie[3]
School of Metallurgy and Materials Engineering, College of Engineering, University of Tehran, North Kargar Street, Tehran, Iran.
Kamali.Mehrshad@gmail.com

Abstract
This paper presents electrochemical performance of nanostructured $(La_{0.75}Sr_{0.25})_{0.95}Cr_{0.5}Mn_{0.5}O_{3-\delta}$ (LSCM)/Y_2O_3-ZrO_2 (YSZ) composite fuel electrode for steam electrolysis in solid oxide electrolyzer cells (SOEC) at 850°C. Solid oxide cells have attracted increasing attention in recent years as a result of their dual application as electricity generators (in fuel cell mode) and hydrogen producer (in electrolyzer mode). In this work, the effects of operating potential and water content of the inlet gas on the electrochemical performance of LSCM/YSZ electrode were investigated. Electrochemical impedance spectrum of LSCM/YSZ electrode was mainly composed of two arcs, one small high frequency arc and a relatively larger low frequency arc. Magnitudes of the low frequency arc, which are dependent on the adsorption/diffusion resistances, were measured as being equal to 9.17 $\Omega.cm^2$ and 5.95$\Omega.cm^2$ for the steam concentrations of 3% and 20%, respectively. Also, the impacts of infiltration of LFC ($LaFe_{0.6}Co_{0.4}O_3$) on the LSCM/YSZ electrode were further investigated in this work. Our obtained results imply that in presence of LFC nanoparticles, the polarization resistances of the composite electrode reduce substantially (1.99 $\Omega.cm^2$ and 1.8 $\Omega.cm^2$ for the steam concentrations of 3% and 20%, respectively). Results of the conducted polarization experiments also revealed the existence of a linear IV curve.

Keywords: SOEC, steam electrolysis, LSCM/YSZ, impedance spectroscopy, infiltration, LFC

Introduction
High-temperature solid oxide cells are considered as reciprocal energy converters between hydrogen (or hydrocarbons) and electricity. This property is due to their reversibility of operation; namely, as solid oxide fuel cells (SOFCs) when generating electricity and as solid oxide electrolysis cells (SOECs) when producing hydrogen via steam electrolysis as well as synthetic fuels via steam-carbon dioxide (CO_2) co-electrolysis.
Applications of the fuel cells have been the subject of a rigorous research in the past two decades; however, more attention has recently been geared towards SOECs. Global environmental issues mainly caused by the shortcomings of the existing energy systems and depletion of the fossil fuels are the most notable reasons for the increasing interest on the SOECs and their applications [1, 2]. Furthermore, abundancy and economical justifiability of the renewable resources like

[1]-Master of Science student of Metallurgy and Materials Engineering (kamali.mehrshad@gmail.com)
[2]-Assistant Professor of Metallurgy and Materials Engineering (alireza.babaei@ut.ac.ir)
[3]-Professor of Metallurgy and Materials Engineering (aataie@ut.ac.ir)