Effects of Ni-Fe additional layer for methane fuel in Solid Oxide Fuel cells

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Solid oxide fuel cells (SOFCs) are considered as the most promising future energy generation system for power plants and distributed power systems. SOFCs, when compared to other fuel cell systems, offer the greater flexibility in terms of fuel by internal reforming of natural gas, ethanol or hydrocarbon fuels, which may occur directly on the anode. One of the challenges of using fuel cells as a commercial alternative for electricity generation is the fact that they usually require high purity hydrogen as fuel. High purity hydrogen conversion and supply in SOFCs add additional levels of complexity to the overall system. Therefore, oxidation of hydrocarbons fuels directly on SOFC anodes has been experimentally demonstrated by a number of groups. Methane is the simplest and widely available hydrocarbon with a huge resource in the world. It is the main component of natural gas and coal gas. It is also the main component of biogas and can be treated as a renewable energy resource. Nowadays, there is a great interest of SOFC operating on methane fuel.

State-of-the-art SOFC anodes are composed of nickel-based cermets which show high electrical conductivity and excellent activity for hydrogen electrochemical oxidation. Sintered nickel has high catalytic activity towards hydrocarbon cracking reaction. However, coke is easily formed over anode surface and causes rapid deterioration of the fuel cell performance when hydrocarbons are applied as the fuels. As a result, Ni-YSZ cermet anodes can only be used for ethanol or hydrocarbon fuel if a high excess of steam to fuel is present in the cell anode in order to ensure complete fuel reforming and to suppress carbon deposition. Therefore, the development of an anode material for SOFCs that operates on ethanol or hydrocarbons at lower carbon to water ratios (at least close to the stoichiometric ratio) is widely recognized to be an important technical objective.

In this paper, a nickel-iron alloy catalyst layer was proposed as a dual-functional layer over traditional Ni–YSZ anode and support for operating on methane fuel. The effects of processing temperature and porosity are discussed. The performances and stabilities of SOFCs were characterized.

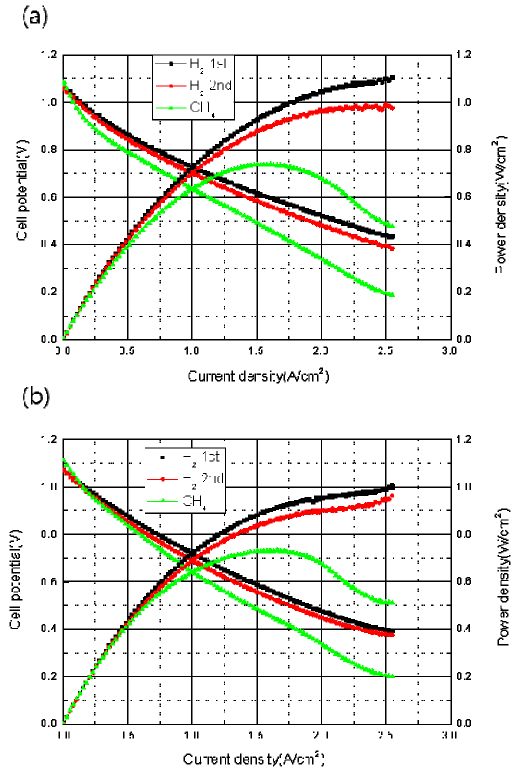

Fig 1 The Fuel Cell Performance of SOFCs (a) without and (b) with Ni-Fe additional layer with methane fuel