Structural and electrochemical properties of interconnect integrated solid oxide fuel cell

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\textbf{ABSTRACT}

Interconnect integrated solid oxide fuel cells (II-SOFC) have remaining design and process issues due to their differences in thermal and mechanical properties between metal and non-metal materials. In this work, a lightweight design of an II-SOFC using metal foam and a high temperature sinters-jointing process, which is one of the less expensive fabrication methods, is proposed for mobile and automotive applications, and the electrochemical performance is evaluated. 8 mol% of Y\textsubscript{2}O\textsubscript{3} stabilized ZrO\textsubscript{2} (8YSZ) is used as electrolyte and NiO/8YSZ as anode material. Ce\textsubscript{0.9}Gd\textsubscript{0.1}O\textsubscript{1.9} (CGO91) and Ba\textsubscript{0.5}Sr\textsubscript{0.5}Ce\textsubscript{0.8}Fe\textsubscript{0.2}O\textsubscript{3-\textgamma} (BSF)/Sm\textsubscript{0.2}Ce\textsubscript{0.8}O\textsubscript{1.9} (SDC) are used as the in-situ buffer layer and in-situ composite cathode, respectively, to avoid oxidation of the metal interconnect, no additional sintering process is employed. A very strong bonding property is achieved at the ceramic-metal interface, the cell has a maximum power density of 0.37 W cm\textsuperscript{-2} at 800° C in hydrogen operating conditions.

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1. Introduction

For use in auxiliary power unit (APU) applications, metal supported solid oxide fuel cells (M-SOFC) have been actively studied to obtain enhanced mechanical strength, sealing efficiency, and quick startup compared to the characteristics of conventional ceramic-supported SOFCs. However, one of the main problems of M-SOFCs is their complicated fabrication process. For example, combining metal and ceramic parts for an M-SOFC is a severe technological obstacle due to the differences in thermal and mechanical properties. For M-SOFCs, the metal part should be oxidation resistant, have good gas transport properties, and show a small coefficient of thermal expansion. Lee et al. [1] and Hui et al. [2] used stainless steel S316 Plates as a support for single cells in SOFCs. Stainless steel and Hastelloy X have been widely used as metal support by several research groups [3–11]. Cho and Joo [12,13] demonstrated the feasibility of Ni powder as a support material. However, the processes involved are expensive and cannot be scaled up to cells with relatively large area.

Another area of interest is lightweight, high power density SOFC stacks, which can be realized through interconnect integrated SOFCs using an alloy foam and the sinter-jointing process. The alloy foam is used as an interconnect as well as a metal support: a fully sintered anode body with an electrolyte is sinter-joined with the alloy foam without using an expensive coating process. Therefore, adoption of the alloy foam as an interconnect and cell supporting metal part can lead to good characteristics such as gas transport and light weight. In this study, the fabrication of interconnect integrated SOFCs (II-SOFC) using alloy foam was carried out and the electrochemical properties of the II-SOFCs were investigated for application in automobiles.

2. Experimental

For the fabrication of interconnect integral Solid Oxide Fuel Cells (II-SOFCs), a fully sintered anode supported ceramic cell comprised of 8 mol% Y\textsubscript{2}O\textsubscript{3} stabilized ZrO\textsubscript{2} (8YSZ, Tosoh) electrolyte and a NiO/8YSZ anode without cathode layer was used. Ce\textsubscript{0.9}Gd\textsubscript{0.1}O\textsubscript{1.9} (CGO91, Praxair, USA) as an in-situ buffer layer...