고온형 수소이온 전도성 산화물 연료전지를 위한 Ni-$BaZr(Y)O_3$ 다공성 음극 지지체의 제조

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Synthesis of Ni-$BaZr(Y)O_3$ porous anode substrate for high temperature proton-conducting oxide fuel cell

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1. Introduction

Recently, ceramic-metal composites (cermets) based on nickel and zirconia are intensively studied due to have their potential applications in sensors, electrolysis, hydrogen separation, and anodes for solid oxide fuel cell [1-2]. Nickel (Ni) is generally used as a metal component because of its high electronic conductivity, high hydrogen oxidation activity and excellent cost performance. Therefore the Ni-BZY cermet would be one of the promising anode electrode with a high performance and multifunctional properties. Yittrium doped $BaZrO_3$ is one of the candidated materials as a proton conducting oxide at high temperature fuel cell [3].

The electrochemical reaction that place at the triple-phase boundaries (TPBs) between gas phase, electron conductor and proton conductor is likely to facilitate the oxidation of hydrogen and absorption of the proton into the proton-conducting electrolyte [4]. To develop highly performance anodes, large surface areas of three-phase boundaris are required for anode structures. The ceramic phase of the cermet should further impart thermal match and chemical compatibility of anode and electrolyte.

The fabrication process of Ni-BZY cermet significantly affects the microstructure and performance [5]. The main approach to optimizing the cermet structure is through

preparation of electrodes by means of controlling the size of Ni and BZY. The ionic resistance and TPBs of the electrode depend on the size and distribution of the constituent particles. The Ni-BZY anode substrate structure has graded pores, so the gas channels or flow fields may be incorporated into the electrodes. The Ni cermet was little studied and its electrochemical behaviour poorly understood due to the complex natures of both the electrode microstructure and electrochemical oxidation of the fuel cell. The nature of this main rate-limiting process is a subject of spillover of protons from the Ni surface to the BZY or electronic conductivity in the BZY electrolyte.

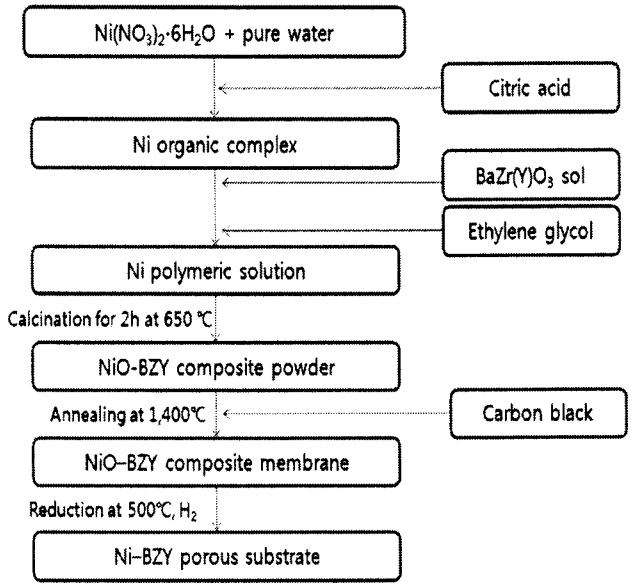

Fig. 1. Flow chart for the synthesis of Ni-BZY porous substrate.

In this study, we synthesized the Ni-$BaZr(Y)O_3$ (Ni-BZY) porous membrane and investigated the single-cell performance using this nickel cermet as anode electrode for proton conducting oxide fuel cells at elevated temperatures.

2. Experimental

Ni-BZY composite powder were prepared by the combustion method and reduction by hydrogen at 500℃ as shown in Fig. 1. The nickel composite powder was mixed with carbon black as a pore-former and compacted under uni-axial pressure to form a disc. Formation of $BaZr(Y)O_3$ electrolyte sol has been described in a recent report [6]. The $BaZr(Y)O_3$ electrolyte thin film was prepared by chemical solution deposition methode for serveral times repeatedly. The morphology the materials were analyzed by X-ray diffractiometry. The microstructure was estimated by gas permeation tests and scanning electronic microscopy. The single cell performances were evaluated at various temperatures under humidity condition.

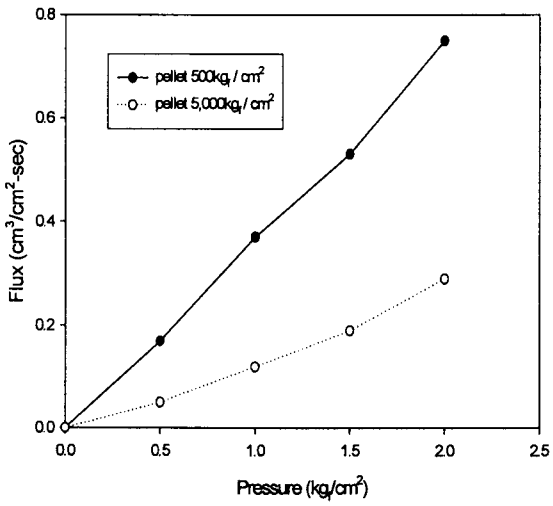

Fig. 2. Permeation test of Ni-BZY porous membranes.

3. Result & Discussion

The green NiO-$BaZr(Y)O_3$ composite membrane was about 10 mm in diameter and about 1 mm in thickness after sintering at 1400 ℃ for 3 hours. The prepared Ni-BZY porous substrate have a sufficient gas permeability as shown in Fig. 2. It is considered that the Ni-cermet synthesized from the starting solution is available for anode substrate of high temperature proton condcuting oxide fuel cell.

4. Reference

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