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# Co-firing Solid Oxide Fuel Cell (SOFC) Components Prepared by Tape Casting and Direct Foaming

E. G. Moraes(1)*, S. Stein(1), H. Birol(1), S. Barg(2), D. Hotza(1), M. C. Fredel(1)

(1) CERMAT Lab - Núcleo de Materiais Cerâmicos, Departamento de Engenharia Mecânica, Universidade Federal de Santa Catarina (UFSC)
(2) Ceramic Materials and Components, University of Bremen, Germany, e-mail: lisguzi@gmail.com
* Corresponding author.

**Abstract** – Direct foaming and tape casting techniques were successfully applied for fabrication of planar SOFC components. The Ni/YSZ anode of the cell, which was prepared by direct foaming, exhibited open porosity up to 35% with pores in the 1-10 µm range (Fig.1), whereas, the dense yttria-stabilized zirconia (YSZ) electrolyte was prepared by tape casting, reaching up to 94% of the theoretical density (Fig.2, 3). These results in addition to the de-lamination-free interface following co-firing demonstrate the adequacy of the applied techniques for preparation of optimized micro and macro structures for SOFC components.

Solid oxide fuel cell (SOFC) is an electrochemical conversion device, which produces electrical energy and heat from chemical energy of fuels by oxidation [1]. It is a layer by layer assembly of individual components such as electrolyte, electrodes, seal, etc…, each of which has a specific function, microstructure and materials class. Consequently, one of the major fabrication and quality-assurance challenges is to maintain physical and chemical compatibility of such adjacent layers, largely differing in materials properties such as coefficient of thermal expansion (CTE).

In this work, the electrolyte of the SOFC, which has to be dense and purely ionic conductor, was prepared by tape casting in two steps: in the first step, the yttria-stabilized zirconia (YSZ) powder (3 % yttria) and dispersant were ball-milled in de-ionized water for 24 h, which was blended with the binder and re-ball-milled for 24 h in the second step. The prepared slip was cast and dried after rheological characterization. The Ni/YSZ anode of the SOFC was prepared by direct foaming, which is a relatively-recent materials processing technique, in two steps; in the first step, Ni and YSZ powders, which were initially dry-mixed at a molar ratio of 50 %, was ball-milled for 2 hours [2]. In the second step, the surfactant and an emulsifier based on high-concentrate alkane phase (pore-former) [3] were added to the initially prepared dispersion, which was then agitated at 2000 rpm for 2 min. The prepared emulsion was then tape-cast on to the previously-cast YSZ tape. Following drying, the YSZ-Ni/YSZ laminate was fired at 1350 ℃ for 2 h.

Scanning electron microscopy (SEM) images reveals the desired micro-structural features for both components: a dense YSZ electrolyte (94 % of the theoretical density) and a porous anode with pore sizes in the 1-10 µm range. Moreover, no de-lamination was observed following co-sintering. The combination of both techniques is believed to be effective in fabrication of multi-layer laminates altering in density and porosity.

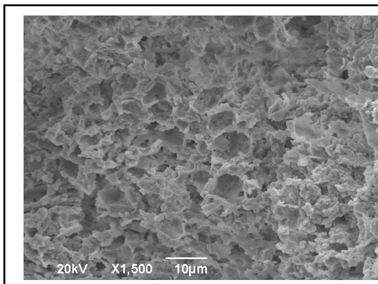


**Figure 1:** Ni/YSZ anode prepared by direct foaming.

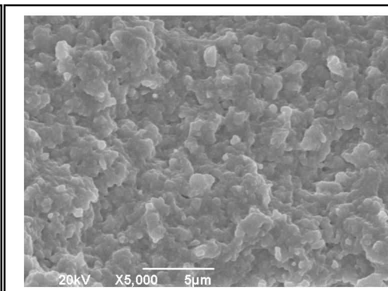


**Figure 2:** YSZ electrolyte prepared by tape casting.

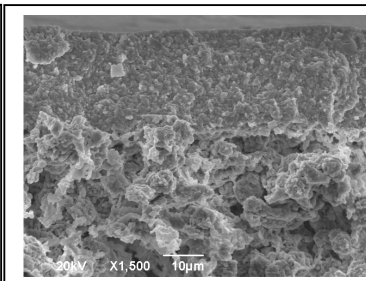


**Figure 3:** Co-fired YSZ – Ni/YSZ laminate.

## References

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