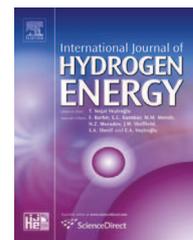


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Effect of anode thickness and Cu content on consolidation and performance of planar copper-based anode-supported SOFC

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ABSTRACT

Planar, Cu-containing Gadolinia-doped ceria anode-supported solid oxide fuel cells to be used at intermediate temperature (500–750 °C) were produced in the present work. The intermediate temperature solid oxide fuel cells were fabricated using Li₂O as sintering aid for Gadolinia-doped ceria, varying the anode-to-electrolyte thickness ratio (*r*) from 2 to 10 and the CuO content in the anode from 45 vol% to 55 vol%. Co-sintering of the thermo-pressed green cells was carried out at 900 °C for 3 h. The electrolyte densification was favoured by increasing the *r* value, this being accounted for the enhanced compressive stresses induced by the supporting anode on the electrolyte upon sintering. Larger CuO content positively influences the overall cell performance, due to the improved electronic conductivity of the anode. Nevertheless, CuO concentration cannot exceed 50 vol% because of the tensile stresses (and corresponding flaws) generated in the electrolyte for larger amount. IT-SOFC containing 50 vol% CuO was characterized by an Open Circuit Voltage ≈ 0.82 V and a maximum power density of 200 mW cm⁻² at 700 °C.

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Introduction

Wide fuel flexibility [1–4], high efficiency and potential coupling within hybrid systems [5–7] are some of the fundamental reasons that make Solid Oxide Fuel Cells (SOFC) among the most promising devices for environmental-friendly energy conversion. The research is currently leading towards the reduction of the operating temperature, within the so called “intermediate temperature” (IT) range (500–750 °C), because of the improved stability and durability

of the system, associated to lower overall costs [8,9]. The first approaches carried out to reduce the operating temperature tended to increase the electrolyte conductivity. This suggested the substitution of traditional yttria-stabilized zirconia (YSZ) with Gadolinia-doped ceria (GDC) [10]. The main issue associated with the use of this latter ceramic is its limited densification unless very high sintering temperatures are used (>1500 °C) [11]. In some cases, sintering aids are used although they can determine variable effects on conductivity [12–15]. Recent works have shown that the use of Li₂O allows to decrease the sintering temperature of GDC down to 950 °C [16].

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GDC electrolyte densification which can be carried out at 900 °C with the use of Li₂O sintering aid. This allows to increase CuO content in the anode and keep the tensile, thermal stress in the electrolyte below the critical level. Dense Li-doped GDC electrolyte can be obtained at 900 °C using ten times thicker 45/50 vol% CuO-containing anode. IT-SOFC containing 50 vol% CuO reaches power density of 200 mW cm⁻² at 700 °C.

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