Compatibility and performance of SOFCs based on lanthanum tungstates

Lucía dos Santos-Gómez[1*], José M. Porras-Vázquez[1], María José Zayas-Rey, Enrique R. Losilla[1] and David Marrero-López[2]

[1]*Universidad de Málaga, Dpto. de Química Inorgánica, 29071-Málaga, Spain*
[2]*Unversidad de Málaga, Dpto. de Física Aplicada I, Laboratorio de Materiales y Superficies (Unidad Asociada al C.S.I.C.), 29071-Málaga, Spain*

(*) e-mail corresponding author: lucia_2_santos@uma.es

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1 Abstract

Rare-earth tungstates with general composition "Ln_6WO_{12}" have attracted great attention in last few years due to their relatively high mixed proton-electron conductivity [1, 2]. One of the main advantages of these electrolytes, compared to the traditional perovskites based on $BaCeO_3$, is that they exhibit high tolerance towards CO_2 and H_2S environments. Therefore, this material is a potential electrolyte for proton conducting solid oxide fuel cells (PC-SOFC).

In this work, the lanthanum tungstate with composition $La_{27}W_4NbO_{55-\delta}$ (LWNO) has been tested as proton conductor electrolyte [3]. For this purpose, different electrodes and composite electrodes have been considered, including: $La_{0.8}Sr_{0.2}MnO_{3-\delta}$, $La_{0.6}Sr_{0.4}Co_{1-x}Fe_xO_{3-\delta}$, $La_{0.5}Sr_{0.5}Cr_{0.5}Mn_{0.5}O_{3-\delta}$, $SrFe_{0.75}Nb_{0.25}O_{3-\delta}$ and NiO.

Chemical compatibility between the cell components is investigated by X-ray powder diffraction (XRPD) and energy dispersive spectroscopy (EDS). Furthermore, area specific resistance (ASR) of the different electrodes is determined in symmetrical cells by impedance spectroscopy. XRPD and EDS analysis do not reveal significant bulk reactivity between most of these electrodes and LWNO electrolyte in the typical operating temperature range of a SOFC (600-900 ºC).

However, minor interdiffusion of elements at the electrolyte/electrode interface affects both the ohmic losses and electrode polarization of the symmetric cells. ASR values are significantly improved by using a buffer layer of $Ce_{0.8}Gd_{0.2}O_{1.9}$, between the electrolyte and electrode materials, to prevent reactivity. A single cell with 350 µm thick electrolyte, NiO-$Ce_{0.8}Gd_{0.2}O_{1.9}$ anode and $La_{0.6}Sr_{0.4}Co_{0.8}Fe_{0.2}O_{3-\delta}$ cathode, generates maximum power densities of 140 and 18 $mWcm^{-2}$ at 900 and 650 ºC, respectively. Hence, lanthanum tungstates could be competitive proton conductors for PC-SOFCs with similar performance to those based on $BaZrO_3$ if thin film electrolytes are used.

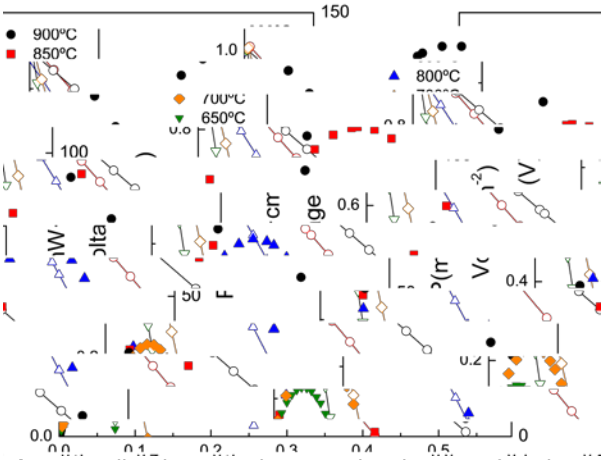

Fig. 1. Cell voltage and power density as a function of current density at different temperatures using air and 5% H_2–Ar as oxidant and fuel respectively.

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3 References

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