Nuria Bausá, Cecilia Solís, Sonia Escolástico and José M. Serra
Instituto de Tecnología Química (Universidad Politécnica de Valencia – Consejo Superior de Investigaciones Científicas), Av. Naranjos s/n, E-46022 Valencia (SPAIN)

Anode development for BCZY based on high temperature protonic electrolyzers

The use of high temperature electrolyzers (HTE) of steam offers high efficiency of conversion of renewable and peak electricity to H_2. In solid oxide electrolyzers (SOECs), that use oxide ion conducting electrolytes and operate at around 800 °C, the hydrogen is produced on the steam feed side. However, in proton conducting electrolyzers (PCECs) a high temperature proton conducting electrolyte is used instead and protons are pumped and form dry H_2, leaving O_2 on the steam side. These PCECs can produce pressurized dry H_2 directly.

$BaCe_{0.2}Zr_{0.7}Y_{0.1}O_{3-\delta}$ (BCZY27) was selected as electrolyte material for the high temperature protonic electrolyzer, thus this study is focused on the study of suitable anodes for this electrolyte.

The compatibility of different proposed phases with the BCZY was tested upon a heat treatment together with the electrolyte and under high temperature and high steam pressure conditions (700 ºC, 1.5 bars of steam in air and 2 bars of total pressure). First selected candidates were $La_{0.8}Sr_{0.2}MnO_3$ (LSM), $Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_3$ (BSCF) and $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_3$ (LSCF). Afterwards, the anodes were prepared as composites by mixing one of these phases with the BCZY27 electrolyte.

Composite anodes were tested by impedance spectroscopy on BCZY27 electrolytes as symmetrical cells as a function of the temperature (800-500 ºC) under air with 1.5 bar of steam, with a total pressure of 2 bars. First screening was performed by using 50-50 vol.% of each phase and LSCF based anode showed the best properties. Then the performance of the LSCF/BCZY27 composite was improved by (1) changing the ratio of the different phases and (2) improving its microstructure.

Finally, a deep study by changing the measurement conditions (mainly steam, pO_2 and total pressures) was carried out in order to analyze and understand the different processes that take place in the anode under realistic operation conditions.