$Bi_2V_{0.9}Cu_{0.1}O_{5.35}$ thin films as alternative electrolytes for low temperature μSOFC

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The development of micro Solid Oxide Fuel Cells (μSOFC) experienced great progress during the first decade of XXI Century, when the classical limits of SOFC technology were overcome in terms of system size and operating conditions (temperature). From a technological point of view, the main achievement was associated to the integration of SOFC functional layers into silicon-based substrates, thus allowing cheap batch production and fabrication of complex and low thermal mass structures. Meanwhile, from a materials perspective, the most important results came from the downscaling of state-of-the-art electrolytes (mainly yttria-stabilized zirconia, YSZ and gadolinia-doped ceria, GDC) to thin film form. Altogether, this allowed lowering the operating temperature of μSOFC down to 400ºC (from classical >700ºC in bulk SOFC), using metals as electrodes. However, nowadays the technology finds himself in a dilemma. While great advances came from lowering the operating temperature, this improvement is still not enough as to impede the fast degradation of the metallic electrodes and further lowering would be necessary for a safe and stable use of metals. Otherwise, exploring different non-metallic electrodes is required, if operation at T>400ºC is targeted.

In this work, superior oxide-ion conducting materials are investigated as electrolytes for low temperature operation of μSOFC. In particular, we present the optimization of $Bi_2V_{0.9}Cu_{0.1}O_{5.35}$ (BICUVOX), material belonging to the aurivillius family, as thin film electrolyte. Although presenting one of the highest ionic conductivity ever reported, its poor chemical stability and low compatibility with other components of the cells traditionally hindered its utilization in classical SOFC systems. However, these limitations could be overcome if downscaling the material to thin films, since operation at reduced temperatures (T<300ºC, where lower degradation is expected) is possible. Here, BICUVOX thin films are deposited by pulsed laser deposition (PLD) method. A complete structural characterization is carried out, aiming to stabilize the high conducting aurivillus tetragonal phase. Then, a correlation with the ionic transport in the films is established, by using electrochemical impedance spectroscopy (EIS). Best performing films shows the potentiality of using this material at temperatures as low as 250ºC (Area-Specific Resistance < 0.15 Ωcm^2 for the electrolyte film). This result entails a significant lowering of the operating temperature of μSOFC systems, opening new prospects for the application of the technology in a new range of temperatures, with great potential for easy integration in real devices.

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