ONE STEP SYNTHESIS OF NANOCOMPOSITE ELECTRODES FOR REVERSIBLE ELECTROCHEMICAL CELLS

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Keywords: *Nanocomposite, Reversible Electrochemical Cell*

The irregular and seasonal disposition of renewable energy requires advanced devices for energy storage and conversion. Reversible electrochemical cells can address this approach by operating as both electrolyzer and fuel cell in an efficient and eco-friendly way. An important issue for increasing the performance of ceramic electrochemical cells is the sluggish oxygen reduction reaction kinetic at the air electrode. Although the intrinsic properties of the ceramic material are of great importance, the real performance strongly depends on the microstructural characteristics, such as porosity, particle size, surface area and electrode-electrolyte adherence.[1] It is well known that the efficiency of air electrodes may be improved by adding a second phase with high ionic conductivity, i.e. doped-CeO_2 and Bi_2O_3, to obtain a composite electrode.[1] Moreover, they are usually employed to reduce the mechanical stress between electrode and electrolyte layers, originated by their different thermal expansion coefficients, thus enhancing the mechanical stability of the cell. Traditionally, composite electrodes are prepared by mechanically mixing pristine materials but, unfortunately, it is difficult to control the composition distribution and architecture with this method.

In this work, different nanocomposite electrodes are successfully prepared by using both the freeze-drying powder precursor method and the spray-pyrolysis deposition, in a single-step synthesis, from precursor solutions containing all cations in stoichiometric amounts. For instance, $La_{0.8}Sr_{0.2}MnO_{3-\delta}$–$Ce_{0.9}Gd_{0.1}O_{1.95}$ (LSM–CGO), $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_{3-\delta}$–$Ce_{0.9}Gd_{0.1}O_{1.95}$ (LSCF–CGO) and $Sm_{0.5}Sr_{0.5}CoO_{3-\delta}$–$Ce_{0.9}Sm_{0.1}O_{1.95}$ (SSC–CSO). Both fluorite and perovskite-based phases are formed simultaneously, reducing drastically the preparation time, which is crucial for potential industrial application. The electrodes are composed of nanometric particles, providing high active area for electrochemical reactions (Figure 1). The intimate mixture of two immiscible phases hinder the cation diffusion and the grain growth rate. Very low polarization resistance values are obtained, i.e. 0.088 Ω cm^2 at 700 °C for SSC–CSO.

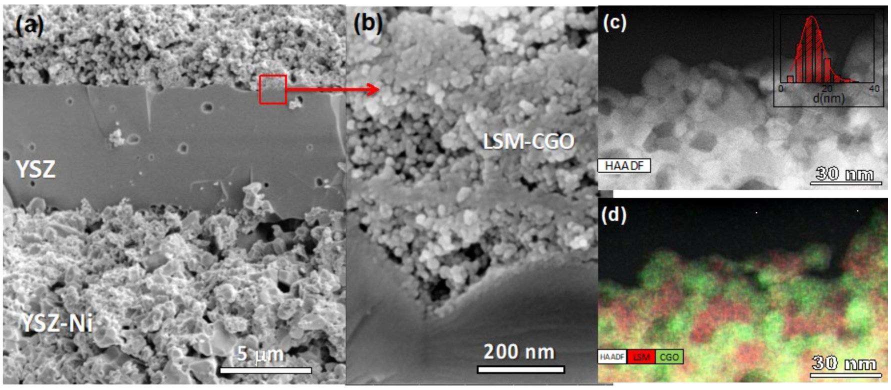

Figure 1. (a,b) SEM images of the cross-section of the LSM–CGO cells. (c) HAADF-STEM image and (d) EDS mapping of the nanocomposite air electrode.

References

[1] L. dos Santos-Gómez et al. *Journal of Power Sources* **2021**, 507, 230277.