

Designed lanthanum nickelate as oxygen electrodes for solid oxide cells by electrostatic spray deposition

Michael Spann (1,2), Lydia Yefsah (1,2), César Steil (1), Laurent Dessemond (1), Jérôme Laurencin (2), Elisabeth Djurado (1)

(1) Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, Grenoble INP, LEPMI, 38000 Grenoble, France

(2) Univ. Grenoble Alpes, CEA, LITEN, DTCH, 17 rue des Martyrs, 38054 Grenoble, France

Tel.: +33-4-76-82-66-84
michael.spann@grenoble-inp.fr

Abstract

Solid oxide cells (SOC) are high-temperature ($T=800^{\circ}\text{C}$) electrochemical systems producing electricity or hydrogen respectively, when operated in a fuel cell (SOFC) or electrolysis mode (SOEC). To limit the degradation and increase the lifetime, they can be operated at an intermediate temperature ($T<700^{\circ}\text{C}$). Nevertheless, in this condition, the SOC performance becomes bounded by the oxygen electrode efficiency. As these electrodes are usually made of mixed ionic and electronic conductors (MIEC) with interesting intrinsic properties such as high oxygen exchange coefficient and high chemical diffusivity, it is of great importance to design the electrode microstructure and architecture. Combining the established screen-printing technology with the alternative electrostatic spray deposition (ESD) bottom-up method, we have successfully designed $\text{La}_{2-x}\text{Pr}_x\text{NiO}_{4+\delta}$ (LPNO) overall electrode architecture with $0 \leq x \leq 2$ [1]. The latter enables to deposit active functional layers (AFL) with unique morphologies and microstructures, which is the key to generating a high number of active sites required for the oxygen reduction/oxidation reactions.

Based on our recent results and the promising electrochemical properties of $\text{La}_{n+1}\text{Ni}_n\text{O}_{3n+1}$ (LNO) [2], this work focuses on the synthesis and electrochemical testing of LNO and composite layers of LNO with GDC by ESD and SP to explore alternative oxygen electrode materials. In the first approach, the impact of microstructure and architecture on electrode performance and stability is investigated. Second, as the ionic exchange benefits from the interplay of different grain sizes and porosity at the electrolyte/ AFL interface, a special emphasis is put on the creation and comparison of an “ex-situ” and an “in-situ” composite layer. The results will be discussed using a kinetic elementary model developed for the LNO [3]. This talk will highlight the influence of grain size and microstructure/architecture of an innovative oxygen electrode on electrochemical results to suggest further improvement of SOC performance.

Keywords

Electrostatic spray deposition, oxygen electrode, solid oxide cells, nickelates

References

- [1] R.K. Sharma, S.K. Cheah, M. Burriel, L. Dessemond, J.M. Bassat, E. Djurado, J. Mater. Chem. A, 5 1120 (2017).
- [2] R.K. Sharma, M. Burriel, L. Dessemond, J.M. Bassat, E. Djurado, Journal of Materials Chemistry A, 4 12451 (2016)

[3] L. Yefsah, C. Hartmann, K. Saravanabavan, G. Sdanghi, J-M. Bassat, E. Djurado, J. Laurencin, Submitted in Fuel Cells (2023).