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# Durability study of the nanostructured $\text{LaPrNiO}_{4+\delta}$ electrode for solid oxide cells

**Elisabeth Djurado<sup>1</sup>, Nur Istiqomah Khamidy<sup>1,2</sup>, Dario Ferreira Sanchez<sup>3</sup>, Federico Monaco<sup>2</sup>, Jérôme Laurencin<sup>2</sup>**

<sup>1</sup>Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, Grenoble INP, LEPMI, 38000 Grenoble

<sup>2</sup>Univ. Grenoble Alpes, CEA/LITEN, 17 rue des Martyrs, 38054, Grenoble, France

<sup>3</sup>Paul Scherrer Institut, 5232 Villigen PSI, Switzerland

Solid oxide cells operating at  $\sim 750\text{-}850^\circ\text{C}$  are efficient energy conversion systems for electrical power generation and hydrogen production but suffer from long-term durability issues. To increase the lifetime, one strategy consists to lower the temperature down to  $600\text{-}700^\circ\text{C}$ . However, one of the main challenges with the lower operating temperature is to decrease the oxygen electrode overpotential by enhancing the oxygen reduction/evolution reaction. To tackle this issue, it is important to choose suitable materials with adequate physical-chemical properties and to optimize the microstructure to further increase the performance. The present work, based on an experimental approach, aims (i) at designing lanthanum-praseodymium nickelate ( $\text{LaPrNiO}_{4+\delta}$ , LPNO) using electrostatic spray deposition (ESD), and/or screen printing (SP) techniques to increase electrochemical performances [1], (ii) at investigating the electrode durability by long-term electrochemical measurements using symmetrical and complete cell configurations [2]. To address this question on the stability, a symmetrical cell of LPNO deposited on a  $\text{Ce}_{0.9}\text{Gd}_{0.1}\text{O}_{2-\delta}$  (GDC) electrolyte is thermally aged at  $700^\circ\text{C}$  for  $\sim 1000$  hours. Long-term durability tests under anodic and cathodic polarizations and versus temperature are also carried out on a symmetrical cell ( $\pm 300$   $\text{mA}/\text{cm}^2$ ,  $700^\circ\text{C}$  for 960 h), as well as on a complete cell ( $-200$   $\text{mA}/\text{cm}^2$  for 900 h) in the electrolysis mode. The complete cell is prepared by depositing LPNO on a half-cell of GDC barrier layer/8YSZ/Ni-YSZ. The performances of the LPNO electrode are not changed when operated under electrolysis current whereas a degradation is observed in fuel cell mode (**Fig. 1**). All the tested electrodes are then characterized by laboratory XRD, synchrotron  $\mu\text{-XRD}$ , and  $\mu\text{-XRF}$  on a beamline at Swiss Light Source (SLS), Paul Scherrer Institute (PSI), Switzerland. Complementary quantitative microstructural analyses are carried out by FIB-SEM tomography. The results are then compared to a pristine symmetrical cell to study the phase stability after aging. For the first time, the distribution of the electrochemically active secondary phases is determined from the electrolyte/electrode interface to the surface of the electrode. To conclude, the suitability of  $\text{LaPrNiO}_{4+\delta}$  (LPNO) as a durable oxygen electrode for electrolysis cells has been proven to be promising.

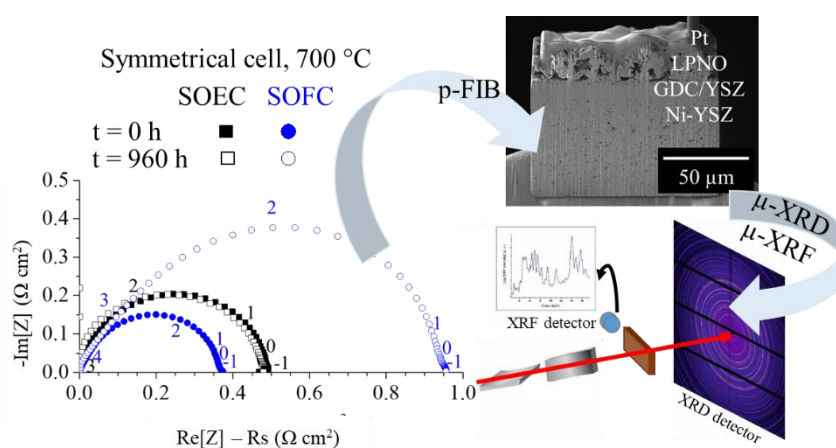


Figure 1. Electrochemical, microstructural, and structural investigation of the durability of LPNO at  $700^\circ\text{C}$  for 960 h.

[2] Khamidy N.I., Laurencin J., Ferreira-Sanchez D., Monaco F., Charlot F., Djurado E., *Journal of Power Sources* **2020**, 450, 227724.